Ravi Maths Tuition

Electric Charges and Fields

12th Standard

Physics

Multiple Choice Question 88 x 1 = 88

1) One metallic sphere A is given positive charge whereas another identical metallic sphere B of exactly same mass as of A is given equal amount of negative charge. Then

(a) mass of A and mass of B still remain equal (b) mass of A increases (c) mass of B decreases
(d) mass of B increases

2) In general, metallic ropes are suspended from the carriers to the ground which take inflammable material. The reason is

(a) their speed is controlled (b) to keep the gravity of the carrier nearer to the earth
(c) to keep the body of the carrier in contact with the earth
(d) nothing should be placed under the carrier

3) In charging by induction

(a) body to be charged must be an insulator (b) body to be charged must be a semiconductor
(c) body to be charged must be a conductor (d) any type of body can be charged by induction

4) Charge on a body is q1 and it is used to charge another body by induction. Charge on second body is found to be q2 after charging. Then

(a) $\frac{q_1}{q_2} = 1$ (b) $\frac{q_1}{q_2} < 1$ (c) $\frac{q_1}{q_2} \leq 1$ (d) $\frac{q_1}{q_2} \geq 1$

5) An object of mass 1kg contains 4 x 10^{20} atoms. If one electron is removed from every atom of the solid, the charge gained by the solid of 1g is _______

(a) 2.8 C (b) 6.4 x 10^{-2} C (c) 3.6 x 10^{-3} C (d) 9.2 x 10^{-4} C

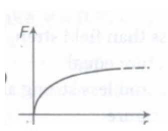
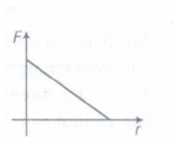
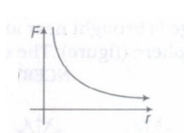
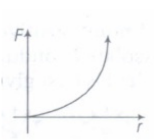
6) Number of electrons present in a negative charge of 8 C is ____________

(a) 5 x10^{19} (b) 2.5 x 10^{19} (c) 12.8 x 10^{19} (d) 1.6 x 10^{19}

7) SI unit of electrical permittivity is

(a) N-m ^{2}C^{-2} (b) Am $^{-2}$ (c) NC^{-1} (d) C^{2}N^{-1}m^{-2}

8) Force between two charges varies with distance between them as

(a) 
(b) 
(c) 
(d) 

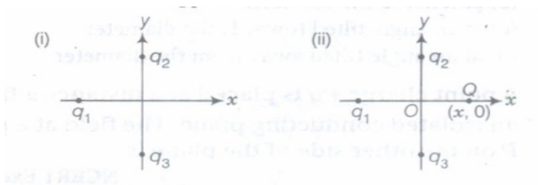
9) Two charges + 1 μ Cand +4μ C are situated at a distance in air. The ratio of the forces acting on them is

(a) 1 : 4 (b) 4 : 1 (c) 1 : 1 (d) 1 : 16

10) A charge q is placed at the centre of the line joining two equal charges Q and Q. The system of the three charges will be ill equilibrium, if q is equal to

(a) -Q /2 (b) -Q/ 4 (c) +Q/ 4 (d) +Q/ 2

11) In figure two positive charges q_2 and q_3 fixed along the y-axis, exert a net electric force in the + x-direction on a charge q_1 fixed along the x-axis. If a positive charge Q is added at (x, 0), the force on q_1



(a) shall increase along the positive x-axis (b) shall decrease along the positive x-axis

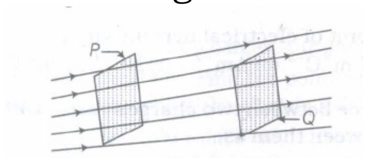
(c) shall point along the negative x-axis

(d) shall increase but the direction changes because of the intersection of Q with q_2 and q_3

12) A force of 2.25 N acts on a chrage of 15 x 10^{-4} C. The intensity of electric field at that point is

(a) 150 NC^{-1} (b) 15 NC^{-1} (c) 1500 NC^{-1} (d) 1.5 NC^{-1}

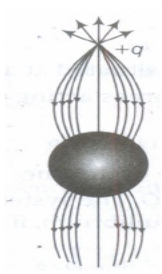
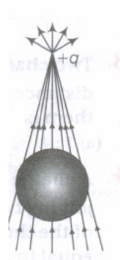
13) In the diagram shown below,



(a) field strength at P is less than field strength at Q (b) field strength at P and Q are equal

(c) field is more strong at P and less strong at Q (d) cannot be tell from the figure

14) A point positive charge is brought near an isolated conducting sphere (figure). The electric field is best given by

(a) 
(b) 
(c) 
(d) 

15) A hemisphere is uniformly charged. The electric field at a point on a diameter away from the centre is directed

(a) perpendicular to the diameter (b) parallel to the diameter

(c) at an angle tilted towards the diameter (d) at an angle tilted away from the diameter

16) A point charge + q is placed at a distance d from an isolated conducting plane. The field at a point P on the other side of the plane is

(a) directed perpendicular to the plane and away from the plane.

(b) directed perpendicular to the plane but towards the plane

(c) directed radially away from the point charge (d) directed radially towards the point charge

17) Two equal and opposite charges each of 2C are placed at a distance of 0.04 m. Dipole moment of the system will be

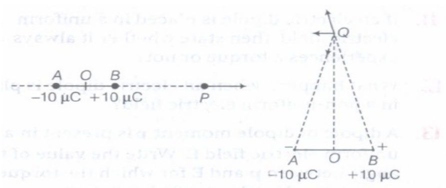
(a) 6 x 10^{-8} C-m (b) 8 x 10^{-2} C-m (c) 1.5 x 10^{2} C-m (d) 8 x 10^{-6} C-m

18) What is the angle between the electric dipole moment and the electric field strength due to it on the equatorial line?

(a) 0^o (b) 90^o (c) 180^o (d) None of these

19) Electric charges q, q, -2q are placed at the corners of an equilateral $\triangle$ABC of side l. The magnitude of electric dipole moment of the system is

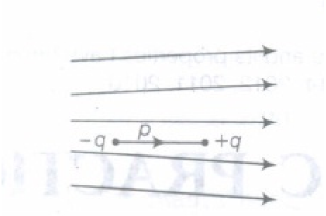
(a) ql (b) 2ql (c) $\sqrt{3}$ ql (d) 4ql

20) 

In given figures, OP = OQ = 15 cm, OA = OB = 2.5 mm Magnitudes of electric field at P and Q are respectively

(a) 2.6×10^5 NC^{-1}, 2.6×10^5 NC^{-1} (b) 1.3×10^5 NC^{-1}, 1.3×10^5 NC^{-1}
(c) 2.6×10^5 NC^{-1}, 1.3×10^5 NC^{-1} (d) 1.3×10^5 NC^{-1}, 2.6×10^5 NC^{-1}

21) Figure shows electric field lines in which an electric dipole P is placed as shown. Which of the following statements is correct?



(a) The dipole will not experience any force. (b) The dipole will experience a force towards right.
(c) The dipole will experience a force towards left. (d) The dipole will experience a force upwards.

22) In an electric field E, the torque acting on a dipole moment p is

(a) p·E (b) p x E (c) zero (d) E x p

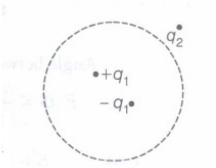
23) When an electric dipole p is placed in a uniform electric field E,then at what angle between p and E the value of torque will be maximum?

(a) 90° (b) 0° (c) 180° (d) 45°

24) The SI unit of electric flux is

(a) $\frac{\text{volt}}{\text{metre}}$ (b) $\frac{\text{newton}}{\text{coulomb}}$ (c) $\frac{\text{newton} \times \text{metre}^2}{\text{coulomb}}$ (d) $\text{volt} \times \text{metre}^2$

25) Consider the charge configuration and spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface, the electric field will be due to



(a) q_2 (b) only the positive charges' (c) all the charges (d) + q_1 and - q_2

26) Total electric flux coming out of a unit positive charge put in air is

(a) E_o (b) ε_0^{-1} (c) $(4\ pE_0)^{-1}$ (d) $4\pi\ E_0$

27) In a system, 'n' electric dipole are placed in a closed surface. The value of emergent electric flux from enclosed surface is

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{2q}{\varepsilon_0}$ (c) $-\frac{2q}{\varepsilon_0}$ (d) zero

28) The intensity of electric field at the surface of conducting hollow sphere is 10 NC^{-1} and its radius is 10 cm. The value of electric field at the centre of sphere is

(a) zero (b) 10 NC^{-1} (c) 1 NC^{-1} (d) 100 NC^{-1}

29) The surface densities on the surfaces of two charged spherical conductors of radii R_1 and R_2 are equal. The ratio of electric intensities on the surfaces are

(a) R_1^2/R_2^2 (b) R_2^2/R_1^2 (c) R_1/R_2 (d) 1:1

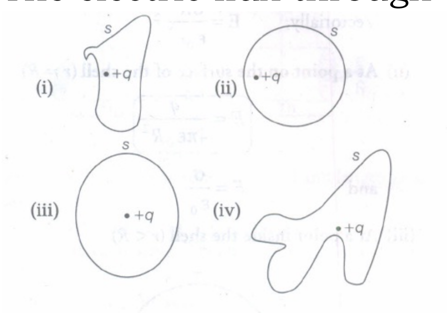
30) The electric flux in a charged spherical conductor is

(a) zero inside and outside the sphere (b) maximum inside the sphere and zero outside the sphere
(c) zero inside the sphere and decreases outside the sphere with increase of square of distance
(d) maximum inside the sphere and decreases outside the sphere with increase of distance

31) Radius of a hollow sphere is R and a charge q is placed at the centre of hollow sphere. If the radius of sphere becomes half and charge also becomes half, then the value of emergent total flux from the surface of sphere is

(a) $4q/\varepsilon_0$ (b) $2q/\varepsilon_0$ (c) $q/2\varepsilon_0$ (d) q/ε_0

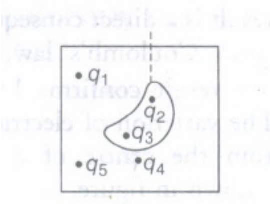
32) The electric flux through the surface



(a) in Figure (iv) is the largest (b) in Figure (iii) is the least

(c) in Figure (ii) is same as Figure (iii) but is smaller than Figure (iv) (d) is the same for all the figures

33) Five charges q_1, q_2, q_3, q_4 and q_5 are fixed at their positions as shown in Figure, S is a Gaussian surface. The Gauss' law is given by $\int_s E \cdot dS = \frac{q}{\varepsilon_0}$ Which of the following statements is correct?



(a) E on the LHS of the above equation will have a contribution from q_1, q_5 and q_1 ,q_5 and q_3 while q on the RHS will have a contribution from q_2 and q_4 only.

(b) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_3 only

(c) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_1, q_3, and q_5 only.

(d) Both E on the LHS and q on the RHS will have contributions from q_2 and q_4 only

34) The number of electrons that must be removed from an electrically neutral silver dollar to give it a charge of + 2.4 C is

(a) 2.5×10^{19} (b) 1.5×10^{19} (c) 1.5×10^{-19} (d) 2.5×10^{-19}

35) Two identical metallic spheres having charges +4q and -2q are placed with their centres r distance apart. Force of attraction between the spheres is F. If the two spheres are brought in contact and then placed at the same distance r apart, the force between them

(a) F (b) F/2 (c) F/4 (d) F/8

36) In the following configuration of charges, force on charge q_2 by q_1 is given by (here,$r = r_{21} = |r_2 - r_1|$)

(a) $\mathbf{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2} \cdot \hat{\mathbf{r}}_{21}$ (b) $\mathbf{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}(-\hat{\mathbf{r}}_{21})$ (c) $\mathbf{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^3} \cdot \hat{\mathbf{r}}_{21}$ (d) $\mathbf{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^3} \cdot (-\hat{\mathbf{r}}_{21})$

37) Let charges q, q and -q are placed at vertices of an equilateral triangle of side I. If F_1, F_2 and F_3 are the forces on the charges respectively, then

(a) $|\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3| = \sqrt{3}\frac{kq^2}{l^2}$ (b) $|\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3| = 0$ (c) $|\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3| = 3\sqrt{2}\frac{kq^2}{l^2}$

(d) $|\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 \quad | = \sqrt{2}\frac{kq^2}{l^2}$

38) Unit of electric field is

(a) N/m (b) C/N (c) N/C (d) J/N

39) Unit of electric field intensity is

(a) N/m (b) C/N (c) N/C (d) J/N

40) The unit of intensity of electric field is

(a) N/m (b) C/N (c) N/C (d) J/N

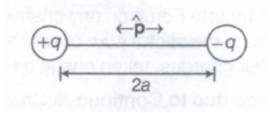
41) Electric field of a system of charges does not depend on

(a) position of charges forming the system

(b) distance of point (at which fieldis being observed) from the charges forming system

(c) value of test charge used to find out the field (d) separation of charges forming the system

42) For the dipole shown,



Dipole moment is given by

(a) p = q x 2a$\hat{p}$ (b) $\mathbf{p} = \frac{1}{2}q \times 2a\hat{\mathbf{p}}$ (c) p = -q x 2a$\hat{p}$ (d) p = 4q x 2a$\hat{p}$

43) Gauss' law is true only if force due to charges varies as

(a) r^{-1} (b) r^{-2} (c) r^{-3} (d) r^{-4}

44) For a given surface, the $\oint \mathbf{E} \cdot d\mathbf{S} = 0$ From this, we can conclude that

(a) E is necessarily zero on the surface. (b) E is perpendicular to the surface at every point

(c) the total flux through the surfaceis zero (d) the flux is only going out of the surface

45) A charge on a sphere of radius 2 cm is 2 μC while charge on sphere of radius 5 cm is 5μC. Find the ratio of an electric field on distance of 10 crn from centre of the sphere.

(a) 1 : 1 (b) 2 : 5 (c) 5 : 2 (d) 4 : 25

46) When a glass rod is rubbed with silk, it

(a) gains electrons from silk. (b) gives electrons to silk (c) gains protons from silk

(d) gives protons to silk.

47) Two similar spheres having +Q and -Q charges are kept at a certain distance. F force acts between the two. If at the middle of two spheres, another similar sphere having +Q charge is kept, then it experiences a force in magnitude and direction as

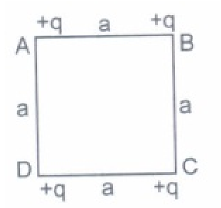
(a) zero having no direction. (b) SF towards +Q charge. (c) SF towards -Q charge.

(d) 4F towards +Q charge

48) A charge Q is divided into two parts of q and Q - q. If the coulomb repulsion between them when they are separated is to be maximum, the ratio of Q/q should be

(a) 2 : 1 (b) 1/2 (c) 4 : 1 (d) 1/4

49) Four equal charges q are placed at the four corners A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be



(a) $\frac{3q^2}{4\pi\varepsilon_0 a^2}$ (b) $\frac{4q^2}{4\pi\varepsilon_0 a^2}$ (c) $\frac{(1+2\sqrt{2})q^2}{2\times 4\pi\varepsilon_0 a^2}$ (d) $\frac{\left(\frac{2+1}{\sqrt{2}}\right)^{q^2}}{4\pi\varepsilon_0 a^2}$

50) Two charges of equal magnitudes kept at a distance r exert a force F on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is

(a) $\frac{F}{8}$ (b) $\frac{F}{4}$ (c) 4 F (d) $\frac{F}{16}$

51) The electric field inside a spherical shell of uniform surface charge density is

(a) zero. (b) constant, less than zero. (c) directly proportional to the distance from the centre.

(d) none of the these

52) A cylinder of radius R and length L is placed in a uniform electric field E parallel to the cylinder axis. The total flux for the surface of the cylinder is given by

(a) $2\pi R^2 E$ (b) πr^2 (c) $\frac{\pi R^2 - \pi R}{E}$ (d) Zero

53) Electric field at a point varies as r^o for

(a) an electric dipole (b) a point charge (c) a plane infinite sheet of charge

(d) a line charge of infinite length

54) An electric charge q is placed at the centre of a cube of side a. The electric flux on one of its faces will be

(a) $\frac{q}{6\varepsilon_0}$ (b) $\frac{q}{\varepsilon_0 a^2}$ (c) $\frac{q}{4\pi\varepsilon_0 a^2}$ (d) $\frac{q}{\varepsilon_0}$

55) The electric field intensity due to an infinite cylinder of radius R and having charge q per unit length at a distance r(r > R) from its axis is

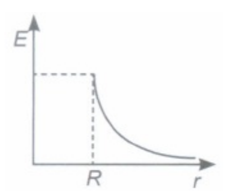
(a) directly proportional to r^2 (b) directly proportional to r^3 (c) inversely proportional to r

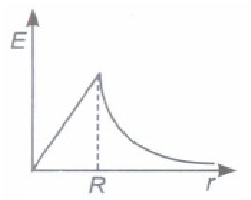
(d) inversely proportional to r^2

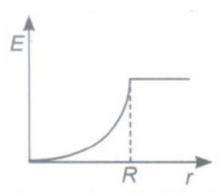
56) A point charge q is placed at a distance a/2 directly above the centre of a square of side a. The electric flux through the square is

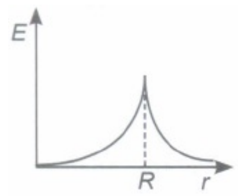
(a) q/ε_0 (b) $q/\pi\varepsilon_0$ (c) $q/4\varepsilon_0$ (d) $q/6\varepsilon_0$

57) Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the sphere?

(a) 

(b) 

(c) 

(d) 

58) The magnitude of electric field intensity E is such that, an electron placed in it would experience an electrical force equal to its weight is given by

(a) mge (b) mg/e (c) e/mg (d) e^2g/m^2

59) Which of the following statement is correct? The electric field at a point is

(a) always continuous (b) continuous if there is a charge at that point

(c) discontinuous only if there is a negative charge at that point

(d) discontinuous if there is a charge at that point

60) Gauss's law will be invalid if

(a) there is magnetic monopoles (b) the inverse square law is not exactly true.

(c) the velocity of light is not a universal constant. (d) none of these

61) An electric dipole of moment p is placed in the position of stable equilibrium in uniform electric field of intensity E. It is rotated through an angle 9 from the initial position. The potential energy of electric dipole in the final position is

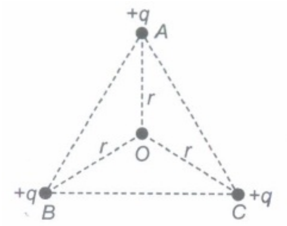
(a) $pE\cos\theta$ (b) $pE\sin\theta$ (c) $pE(1-\cos\theta)$ (d) $-pE\cos\theta$

62) An electric dipole is kept in a non-uniform electric field. It experiences

(a) a force and a torque (b) a force but not a torque (c) a torque but not a force.

(d) neither a force nor a torque

63) ABC is an equilateral triangle. Three charges +q are placed at each comer. The electric intensity at O will be

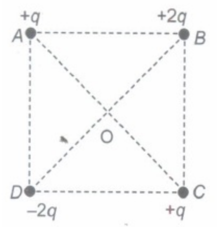


(a) $1. q/4\pi\varepsilon_0 . r^2$ (b) $1. q/4\pi\varepsilon_0 r$ (c) Zero (d) $1. 3q/4\pi\varepsilon_0 r^2$

64) There are two charges +1 µC and +5 µC. The ratio of the forces acting on them will be

(a) 1 : 5 (b) 1 : 1 (c) 5 : 1 (d) 1 : 25

65) Four charges are arranged at the comers of a square ABCD, as shown. The force on the charge kept at the centre O is



(a) zero (b) along the diagonal AC (c) along the diagonal BD (d) perpendicular to side AB

66) Which of the following statement is correct? $\int E \cdot ds = 0$ over a surface, then

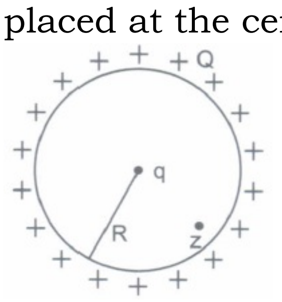
(a) the electric field inside the surface and on it is zero.

(b) the electric field inside the surface is necessarily uniform.

(c) the number of flux lines entering the surface must be equal to the number of flux lines leaving it.

(d) all charges must not necessarily be outside the surface.

67) A positive charge Q is uniformly distributed along a circular ring of radius R. A small test charge q is placed at the centre of the ring.



Which of the following statement is not correct?

(a) If q > 0 and is displaced away from the centre in the plane of the ring, it will be pushed back towards the centre.

(b) If q < 0 and is displaced away from the centre in the plane of the ring, it will never return to the centre and will continue moving till it hits the ring.

(c) If q < 0, it will perform SHM for small displacement along the axis.

(d) q at the centre of the ring is in an unstable equilibrium within the plane of the ring for q > 0.

68) The magnitude of the electric field due to a point charge object at a distance of 4.0m is 9N/C. From the same charged object the electric field of magnitude, 16 N/C will be at a distance of

(a) 1m (b) 2m (c) 3m (d) 6m

69) A negatively charged object X is repelled by another charged object Y. However, an object Z is attracted to object Y Which of the following is the most possibility for the object Z ?

(a) Positively charged only (b) Negatively charged only (c) Neutral or positively charged

(d) Neutral or negatively charged

70) In an experiment, three microscopic latex spheres were sprayed into a chamber and became charged with charges+ 3e, + 5e and- 3e, respectively. All the three spheres came in contact simultaneously for a moment and got separated. Which one of the following are possible values for the final charge on the spheres ?

(a) + 5e, - 4e, + 5e (b) + 6e, + 6e, - 7e (c) + 4e, + 3.5e, + 5.5e (d) + 5e, - 8e, + 7e

71) An object has charge of 1 Cand gains 5.0×10^{18} electrons. The net charge on the object becomes

(a) - 0.80 C (b) + 0.80 C (c) + 1.80 C (d) + 0.20 C

72) The number of electrons that must be removed from an electrically neutral silver dollar to give it a charge of + 2.4 C is

(a) 2.5×10^{19} (b) 1.5×10^{19} (c) 1.5×10^{-19} (d) 2.5×10^{-19}

73) An isolated point charge particle produces an electricfield E at a point 3m away from it. The distance of the point at which the field is $\frac{E}{4}$ will be

(a) 2 m (b) 3 m (c) 4 m (d) 6 m

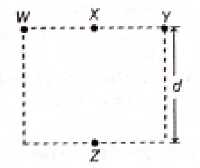
74) An electron experiences a force $(1.6 \times 10^{-16}$ N) $\hat{\mathbf{i}}$ in an electric field E. The electric field E is

(a) $\left(10 \times 10^{3} \frac{\mathrm{N}}{\mathrm{C}}\right) \hat{\mathbf{i}}$ (b) $-\left(10 \times 10^{3} \frac{\mathrm{N}}{\mathrm{C}}\right) \hat{\mathbf{i}}$ (c) $\left(10 \times 10^{-}3 \frac{\mathrm{N}}{\mathrm{C}}\right) \hat{\mathbf{i}}$ (d) $-\left(10 \times 10^{-}3 \frac{\mathrm{N}}{\mathrm{C}}\right) \hat{\mathbf{i}}$

75) Two charges q_1 and q_2 are placed at the centres of two spherical conducting shells of radius r_1 and r_2 respectively. The shells are arranged such that their centres are d [> (r_1+r_2)] distance apart.
The force on q_2 due to q_1 is

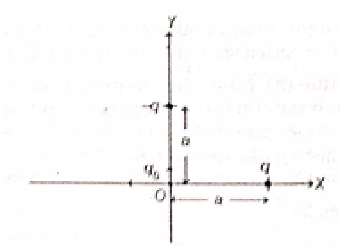
(a) $\frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{d^2}$ (b) $\frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{(d-r_1)^2}$ (c) Zero (d) $\frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{[d-(r_1+r_2)]^2}$

76) Four objects W, X, Y and Z each with charge + q are held fixed at four points of a square of side d as shown in the figure. Objects X and Z are on the mid-points of the sides of the square. The electrostatic force exerted by object W on object X is F, then the magnitude of the force exerted by object W on Z is



(a) $\frac{F}{7}$ (b) $\frac{F}{5}$ (c) $\frac{F}{3}$ (d) $\frac{F}{2}$

77) Three charges q_1 -q and q_0 are placed as shown in figure. The rnagnitude of the net force on the 1 charge q_0 at point O is $\left(\text{Take, } K=\frac{1}{4\pi\varepsilon_0}\right)$



(a) 0 (b) $\frac{2Kqq_0}{a^2}$ (c) $\frac{\sqrt{2}Kqq_0}{a^2}$ (d) $\frac{1}{\sqrt{2}} \frac{Kqq_0}{a^2}$

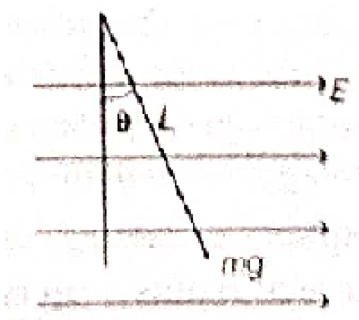
78) Two point charges + 8q and- 2q are located at X=0 and x=L, respectively. The point on X-axis at which net electric field is zero due to these charges, is

(a) 8L (b) 4L (c) 2L (d) L

79) Two parallel large thin metal sheets have equal surface densities 26.4×10^{-12} C/m^2 of opposite signs. The electric field between these sheets is

(a) 1.5 N/C (b) 15×10^{-16} N/C (c) 3×10^{-10} N/C (d) 3 N/C

80) A small object with charge q and weight mg is attached to one end of a string of length L attached to a stationary support. The system is placed in auniform horizontal electric field E, as shown in the given figure. In the presence of the field, the string makes aconstant angle 0 with the vertical. The sign and magnitude of q



(a) positive with magnitude mg/E (b) positive with magnitude mg/E tanθ

(c) negative with magnitude mg/E tanθ (d) positive with magnitude E tanθ/mg

81) An electric dipole of moment p is placed parallel to the uniform electrie tield. The amount of work done in rotating the dipole by 90° is

(a) 2pE (b) pE (c) pE/2 (d) zero

82) For a given surface, the ∫E.ds = 0. From this, we can conclude that

(a) E is necessarily zero on the surface (b) E is perpcndicularto the surface at every point

(c) the total flux through the surface is zero (d) the flux is only going out of tlhe surface

83) A charge on a sphere of radius 2 cm is 2μC while charge on sphere of radius 5 cm is 5μC. Find the ratio of an electric field on distance of 10 cm from centre of the sphere.

(a) 1 : 1 (b) 2 : 5 (c) 5 : 2 (d) 4 : 25

84) Two identical small conducting balls B, and B, are given -7 pC and + 4 pC charges respectively. They are brought in contact with a third identical ball Ba and then separated. If the final charge on each ball is -2 pC, the initial charge on B was

(a) -2 pC (b) -3 pC (c) -5 pC (d) -15 pC

85) The quantum nature of light explains the observations on photoelectric effect as

(a) there is a minimum frequency of incident radiation below which no electrons are emitted.

(b) the maximum kinetic energy of photoelectrons depends only on the frequency of incident radiation.

(c) when the metal surface is illuminated, electrons are ejected from the surface after sometime.

(d) the photoelectric current is independent of the intensity of incident radiation.

86) A charge Q is placed at the centre of a cube. The electric flux through one if its face is

(a) $\frac{Q}{\varepsilon_0}$ (b) $\frac{Q}{6\varepsilon_0}$ (c) $\frac{Q}{8\varepsilon_0}$ (d) $\frac{Q}{3\varepsilon_0}$

87) The direction of induced current in the loop abc is

(a) along abc if I decreases (b) along acb if I increases (c) along abc if I is constant

(d) along abc if I increases

88) An infinite long straight wire having a charge density λ is kept along YY'-axis in XY-plane. The Coulomb force on a point charge q at a point P (x, 0) will be

(a) attractive and $\frac{q\lambda}{2\pi\varepsilon_0 x}$ (b) repulsive and $\frac{q\lambda}{2\pi\varepsilon_0 x}$ (c) attractive and $\frac{q\lambda}{\pi\varepsilon_0 x}$ (d) repulsive and $\frac{q\lambda}{\pi\varepsilon_0 x}$

Fill up / 1 Marks 2 x 1 = 2

89) Two charges q_1 and q_2 are placed in vacuum at a distance d and the force acting between them is F. If a medium of dielectric constant 4 is introduced around them, the force now will be _________.

90) When 10^{14} electrons are removed from a neutral metal sphere, the charge on the sphere becomes __________.

Assertion and reason 29 x 1 = 29

91) **Assertion (A) :** If there exists coulomb attraction between two bodies, both of them may not be charged.

Reason (R): In coulomb attraction two bodies are oppositely charged.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

92) **Assertion (A) :** No two electric lines of force can intersect each other.

Reason (R) : Tangent at any point of electric line of force gives the direction of electric field.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

93) **Assertion (A) :** Electric force acting on a proton and an electron, moving in a uniform electric field is same, where as acceleration of electron is 1836 times that of a proton.

Reason (R) : Electron is lighter than proton.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

94) **Assertion (A)** : As force is a vector quantity, hence electric field intensity is also a vector quantity.

Reason (Rr: The unit of electric field intensity is newton per coulomb.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

95) **Assertion (A) :** Sharper is the curvature of spot on a charged body lesser will be the surface charge density at that point.

Reason (R) : Electric field is non-zero inside a charged conductor.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

96) **Assertion (A) :** The surface densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal.

Reason (R) : Surface density is ,equal to charge per unit area.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

97) **Assertion (A) :** Three equal charges are situated on a circle of radius r such that they form on equilateral triangle, then the electric field intensity at the centre is zero.

Reason (R) : The force on unit positive charge at the centre, due to the three equal charges are represented by the three sides of a triangle taken in the same order. Therefore, electric field intensity at centre is zero.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

98) **Assertion (A) :** The electric lines of forces diverges from a positive charge and converge at a negative charge.

Reason (A) : A charged particle free to move in an electric field always move along an electric line of force.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

99) **Assertion (A) :** Charging is due to transfer of electrons.

Reason (R) : Mass of a body decreases slightly when it is negatively charged.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

100) **Assertion (A)** : Range of Coulomb force is infinite.

Reason (R) : Coulomb force acts between two charged particles.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

101) **Assertion (A) :** A small metal ball is suspended in a uniform electric field with an insulated thread. If high energy X-ray beam falls on the ball, the ball will be deflected in the electric field.

Reason (R) : X-rays emits photoelectron and metal becomes negatively charged.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

102) **Assertion (A) :** If a point charge be rotated in a circle around a charge, the work done will be zero.

Reason (R) : Work done is equal to dot product of force and distance.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

103) **Assertion (A) :** A point charge is lying at the centre of a cube of each side. The electric flux emanating from each surface of the cube is $\frac{1}{6}^{\text{th}}$ of total flux.

Reason (R) : According to Gauss theorem, total electric flux through a closed surface enclosing a charge is equal to $1/\varepsilon_0$ times the magnitude of the charge enclosed.

Codes:

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

104) **Assertion (A)** : A point charge is brought in an electric field. The field at a nearby point is increase, whatever be the nature of the charge.

Reason (R) : The electric field is independent of the nature of charge.

Codes:

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

105) **Assertion (A)** : For charge to be in equilibrium, sum of the forces on charge due to rest of the two charges must be zero.

Reason (R) : A charge is lying at the centre of the line joining two similar charges each which are fixed. The system will be in equilibrium if that charge is one fourth of the similar charges.

Codes:

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

106) **Assertion (A)** : If a conducting medium is placed between two charges, then electric force between them becomes zero.

Reason (R) : Reduction in a force due to introduced material is inversely proportional to its dielectric constant.

Codes:

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

107) **Assertion (A) :** In electrostatics, electric lines of force can never be closed loops, as a line can never start and end on the same charge.

Reason (R) : The number of electric lines of force originating or terminating on a charge is proportional to the magnitude of charge.

Codes:

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

108) **Assertion (A) :** If a point charge q is placed in front of an infinite grounded conducting plane surface, the point charge will experience a force.

Reason (R) : This force is due to the induced charge on the conducting surface which is at zero potential.

Codes:

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

109) **Assertion (A) :** Charge is quantized.

Reason (R) : Charge which is less than 1 C is not possible.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

110) **Assertion (A)** : The electric flux emanating out and entering a closed surface are 8 x 10^3 and 2 x 10^3 V m respectively. The charge enclosed by the surface is $0.053 \mu C$.

Reason (R) : Gauss's theorem in electrostatics may be applied to verify.

Codes:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false and R is also false

111) Assertion(A) : If a point charge be revolved in a circle around another charge as the centre of circle, tlhen work done by electric field will be Zero.

Reason (R) Work done is equal to dot product of force and displacement.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

112) Assertion(A) : A positive point charge initially at rest in a uniform electric field starts moving along electric lines of force. (Neglect all other forces except electric forces).

Reason (R) : A point charge released from rest in an electric field always moves along the line of force.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

113) Assertion(A) : Electric force between two charges always acts along the line joining the two charges

Reason (R) : Electric force is a conservative force.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

114) Assertion (A) : When a neutral body acquires positive charge, its mass decreases.

Reason (R) : A body acquires positive charge when it loses electrons.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

115) Assertion (A) : In a non-uniform electric field, a dipole will have translatory as well as rotatory motion.

Reason (R) : In a non-uniform electric field, a dipole experiences a force as well as torque.

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

116) Assertion (A) : Upon displacement of charges within a closed surface, E at any point on the surface does not change.
Reason (R) The flux crossing through a surface is independent closed of the location of charge within the surface.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Assertion is false but Reason is true.

117) Assertion (A) : If Gaussian surface docs not enclose any charge, then Eat any point on the Gaussian surface must be zero.
Reason (R) : No net charge is enclosed by Gaussian surface, so net flux passing through the surface is zero.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Assertion is false but Reason is true.

118) Assertion (A) : Surface charge density of an irregularly shaped conductor is non-uniform.
Reason (R) : Surface charge density is defined as Charge per unit area.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Assertion is false but Reason is true.

119) Assertion (A) : Total flux through a closed surface iszero, if no charge is enclosed by the surface.
Reason(R) : Gauss' law is true for any closed surface, no matter what its shape or size is.
(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) Assertion is true but Reason is false.
(d) Assertion is false but Reason is true.

2 Marks 197 x 2 = 394

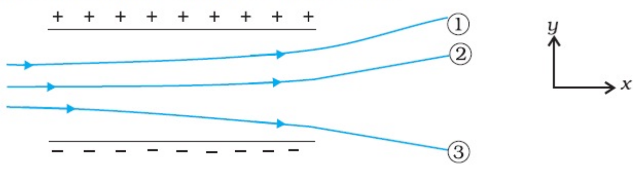
120) How much positive and negative charge is there in a cup of water?

121) (a) Explain the meaning of the statement 'electric charge of a body is quantised'.
(b) Why can one ignore quantisation of electric charge when dealing with macroscopic i.e., large scale charges?

122) When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consistent with the law of conservation of charge?

123) (a) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks. Why not?
(b) Explain why two field lines never cross each other at any point?

124) The Figure shows tracks of three charged particles in a uniform electrostatic field. Give the signs of the three charges. Which particle has the highest charge to mass ratio?



125) What is the net flux of the uniform electric field through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes ?

126) An electric dipole with dipole moment $4x10^{-9}$C-m is aligned at 30° with the direction of a uniform electric field of magnitude 5 $x10^{-4}$ N/C. Calculate the maynitude of the torque acting on the dipole.

127) A ring of radius R carries a uniformly distributed charge +Q. A point charge -q is placed on the axis of the ring at a distance from rest. Will the particle execute simple harmonic motion along the axis of the ring?

128) A dipole of dipole moment p is present uniform electric field E. Write the value of the angle between p and E for which the torque, experienced by the dipole in minimum.

129) A comb run through one's hair attracts small bits of paper. What happens, if the hair are wet or it is a rainy day?

130) A glass rod when rubbed with silk cloth acquires a charge 1.6×10^{-13} C. What is the charge on the silk cloth?

131) Consider three charged bodies A , B and C. If A and B repel each other and A attracts C, then what is nature of the force between B and C?

132) What does $q_1 + q_2 = 0$ signify in electrostatics ?

133) Which property of dielectrics make them different from conductors?

134) Two insulated charged copper spheres A and B of identical size have charges q_A and q_B respectively. A third sphere C of the same size but uncharged is brought in contact with the first and then in contact with the second and finally removed from both. What are the new charges on A and B?

135) What is the basic cause of quantisation of charge?

136) Can a body has charge 1.5 e, where e is the electronic charge?

137) Which is bigger, a coulomb of charge or a charge on an electron?

138) "An object becomes positively charged through the removal of negatively charged electrons rather than through the addition of positively charged protons". Explain, why?

139) A glass object is charged to +3 nC by rubbing it with a silk cloth. In this rubbing process, have protons been added to the object or have electrons been removed from it?

140) In filling the gasoline tank of an aeroplane, the metal nozzle of hose from the gasoline truck is always carefully connected to the metal body of the aeroplane by a wire, before the nozzle is inserted in the tank. Explain, why?

141) Automobile ignition failure occurs in damp weather. Explain, why?

142) A bird perches on a bare high power line and nothing happens to the bird. A man standing on the ground touches the same line and gets a fatal shock. Why?

143) An ebonite rod held in hand can be charged by rubbing with flannel but a copper rod cannot be charged like this, why?

144) Ordinary rubber is an insulator. But the special rubber tyres of aircrafts are made slightly conducting. Why is this necessary?

145) Why does a charged glass rod attract a piece of paper?

146) Can a charged body attract another uncharged body? Explain .

147) Can two balls having same kind of charge on them attract each other? Explain

148) Can ever the whole excess charge of a body P be transferred to the other body Q? If yes, how and if not, why?

149) A balloon gets negatively charged by rubbing ceilings of a wall. Does this mean that the wall is positively charged? Why does the balloon eventually fall?

150) A paisa coin is made up of AI-Mg alloys and weighs 0.75 g. It has a square shape and its diagonal measures 17 mm. It is electrically neutral and contains equal amount of positive and negative charges. Treating the paisa coins made up of only AI, find the magnitude of equal number of positive and negative charges. What conclusion do you draw from this magnitude?

151) What is the total charge of a system containing five charges + 1,+2, - 3, +4 and -5 in some arbitrary unit?

152) How many electrons are there in one coulomb of negative charge?

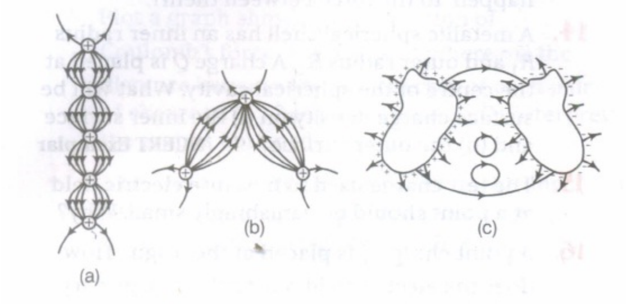
153) A metal sphere has a charge of - 6 μC. When 5 x 10^{12} electrons are removed from the sphere, what would be net charge on it?

154) What charge would be required to electrify a sphere of radius 25 cm, so as to get a surface charge density of $\frac{3}{\pi}$ cm^{-2}?

155) The radius of gold nucleus (Z = 79) is about 7.0 x 10 $^{-15}$m. Assuming that the positive charge is distributed uniformly throughout the nuclear volume, find the volume charge density

156) Two point charges + Q and +4Q are separated by a distance of 6a . Find the point on the line joining the two charges, where the electric field is zero.

157) Explain, why the following curves cannot possibly represent electrostatic field lines?



158) Does the Coulomb force that one charge exerts on another charge changes, if other charge is brought nearby?

159) In Coulomb's law, $F = \frac{k_e q_1 q_2}{r^2}$, what are the factors on which the proportionality constant k_e depends?

160) If the distance between two equal point charges is doubled and their individual charges are also doubled, then what would happen to the force between them?

161) A metallic spherical shell has an inner radius R_1 and outer radius R_2. A charge Q is placed at the centre of the spherical cavity. What will be surface charge density on
(i) the inner surface and
(ii) the outer surface

162) The test charge used to measure electric field at a point should be vanishingly small. Why?

163) A point charge q is placed at the origin. How does the electric field due to the charge vary with the distance r from the origin?

164) Force experienced by an electron in an electric field is F newton. What will be the force experienced by a proton in the same field? Take, mass of a proton is 1836 times the mass of an electron.

165) Two point charges of + 3 μC each are 100 cm apart. At what point on the line joining the charges will the electric field intensity be zero?

166) A proton is placed in a uniform electric field directed along a positive X-axis. In which direction will it tend to move?

167) Why electrostatic field be normal to the surface at every point of a charged conductor?

168) An electrostatic field line is continuous curve, i.e. a field line cannot have sudden breaks. Why not?

169) Why should electrostatic field be zero inside a conductor?

170) Why do the electric field lines not form closed loops?

171) The dimensions of an atom are of the order of an angstrom. Thus, there must be large electric fields between the protons and electrons. Why, then is the electrostatic field inside a conductor zero?

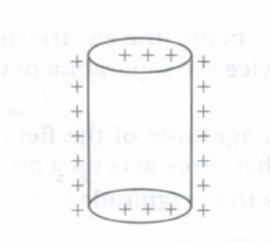
172) In the given statement, point out the correct or incorrect word or phrase with a proper. explanation.
"The mutual forces between two charges do not get affected by the presence of other charges".

173) Plot a graph showing the variation of Coulomb's force (F) versus $(1/r^{2})$, where r is the distance between the two charges of each pair of charges (1μC, 2μ C) and (1μC, - 3 μC).Interpret the graphs obtained.

174) A charge q is placed at the centre of the line joining two equal charges (Q). Show that the system of three charges will be in equilibrium, if $q = -\frac{Q}{4}$

175) An uncharged metallic ball is suspended in the region between two vertical metal plates. If the two plates are charged, one positively and one negatively, then describe the motion of the ball after it is brought into contact with one of the plates.

176) Sketch the electric field lines for a uniformly charged hollow cylinder as shown in the figure.



177) The dielectric constant of water is 80. What is its permittivity?

178) Two equal balls having equal positive charge q coulombs are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two?

179) Two point charges having equal charges separated by 1m distance experience a force of 8 N. What will be the force experienced by . them, if they are held in water, at the same distance? (Given, K_{water} = 80)

180) A charge q = 1μCis placed at point (1m, 2m, 4 m). Find the electric field at point P (0 m, - 4 m, 3 m).

181) An infinite number of charges each equal to q are placed along X-axis at x = 1, x = 2, x = 4, x = 8 and so on. Find the electric field at the point x = 0 due to this set up of charges.

182) Is it correct to write the unit of electric dipole moment as mC?

183) What do you mean by an "ideal electric dipole"?

184) At what points dipole field intensity is parallel to the line joining the charges?

185) If an electric dipole is placed in a uniform electric field, then state whether it always experiences a torque or not?

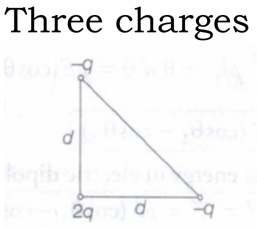
186) What happens when an electric dipole is placed in a non-uniform electric field?

187) A dipole of dipole moment p is present in a uniform electric field E. Write the value of the angle between p and E for which the torque, experienced by the dipole is minimum.

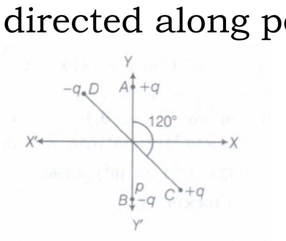
188) A ring of radius R carries a uniformly distributed charge + Q. A point charge - q is placed on the axis of the ring at a distance 2R from the centre of the ring and released from rest. Will the particle execute simple harmonic motion along the axis of the ring?

189) What is meant by the statement, "the electric field of a point charge has spherical symmetry, whereas that of an electric dipole is cylindrically symmetric"?

190) Three charges are placed as shown. Find dipole moment of the arrangements.



191) Two small identical dipoles AB and CD, each of dipole moment p are kept at an angle of 120° as shown in the figure.
What is the resultant dipole moment of this combination? If this system is subjected to electric field (E) directed along positive x-direction, what will be the magnitude and direction ofthe torque acting on this?



192) A dipole, with a dipole moment of magnitude p, is in stable equilibrium in an electrostatic field of magnitude E. Find the work done in rotating this dipole to its position of unstable equilibrium.

193) Find the electric dipole moment electron and a proton which distance is 4.3 nm apart.

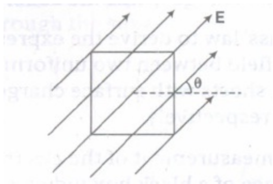
194) Two charges of - 9μC and + 9μC are placed at the points P(1, 0, 4) and Q(2, -1, 5) located in an electric field E = 0.20 $\hat{i}$ V/ cm. Calculate the torque acting on the dipole.

195) Two charges of +25 x 10^{-9}C and - 25x 10^{-9} C are placed 6 m apart. Find the electric field at a point 4 m from the centre of the electric dipole
(i) on axial line
(ii) on equatorial line

196) Can Gauss' law in electrostatics tell us exactly, where the charge is located within the Gaussian surface?

197) An arbitrary surface encloses a dipole. What is the electric flux through this surface?

198) A square surface of side l metres in the plane of paper is placed in a uniform electric field E acting along the same plane at an angle θ with the horizontal side of square as shown in the figure. What is the electric flux linked to the surface?



199) What is the number of electric field lines that radiate outward from one coulomb of charge in vacuum?

200) Does the strength of electric field due to an infinite long line charge depend upon the distance of the observation point from the line charge?

201) How does electric field at a point charge vary with distance r from an infinitely long charged wire?

202) Does the strength of electric field due to an infinite plane sheet of charge depend upon the distance of the observation point from the sheet of charge?

203) How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased?

204) Two charges of magnitudes - 2Q and + Q are located at points (a, 0) and (4a, 0), respectively. What is the electric flux due to these charges through a sphere of radius 3a with its centre at the origin?

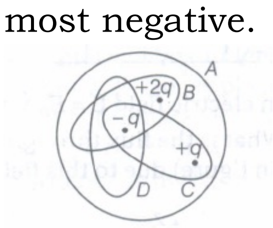
205) What is the electric flux through a cube of side 1cm which encloses an electric dipole?

206) (i) A charge q is placed at the centre of a cube. What is the electric flux passing through each face of cube?
(ii) If radius of Gaussian surface enclosing some charge q is halved, then how does electric flux through Gaussian surface change?

207) If the total charge enclosed by a surface is zero, does it imply that the electric field everywhere on the surface is zero, conversely, if the electric field everywhere on the surface is zero? Does it imply the net charge inside is zero?

208) A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change?

209) Rank the Gaussian surfaces as shown in the figure. In order of increasing electric flux, starting with the most negative.



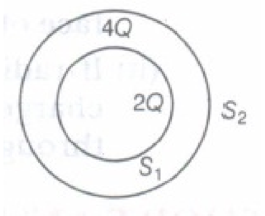
210) Deduce Coulomb's law from Gauss' law

211) What will be the electric field intensity at the centre of a uniformly charged circular wire of linear charge density?

212) A thin straight infinitely long conducting wire having charge density λ is enclosed by a cylindrical surface of radius r and length l, its axis coinciding with the length of the wire. Find the expression for the electric flux through the surface of the cylinder.

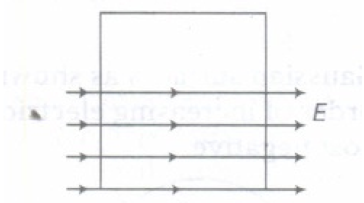
213) A hemispherical body is placed in a uniform electric field E. What is the flux associated with the curved surface, if field is
(i) parallel to base?
(ii) perpendicular to base?

214) Consider two hollow concentric spheres S_1 and S_2 enclosing charges 2Q and 4Q respectively as shown in the figure .

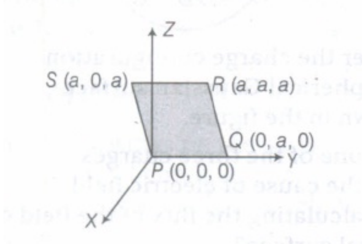


(i) Find out the ratio of the electric flux through them.
(ii) How will the electric flux through the sphere S_1 change, if a medium of dielectric constant e_r is introduced in the space inside S_1 in place of air? Deduce the necessary expression.

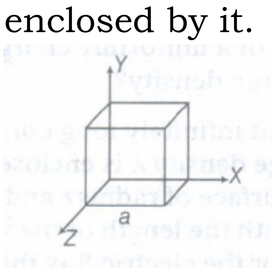
215) A square surface of side l metre is in the plane of paper. Auniform electric field E (volt/metre), also in the plane of the paper, is limited only to the lower half of the square surface, (see figure). What is the electric flux associated with this surface?



216) Consider an electric field E = $E_0\,\hat{x}$, where Eo is a constant. What is the flux through the shaded area (as shown in figure) due to this field.

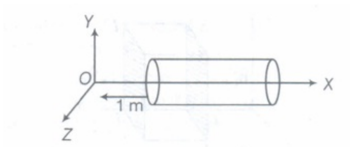


217) Given the electric field in the region E = $2x\hat{i}$, find the net electric flux through the cube and the charge enclosed by it.



218) Given a uniform electric field E = 5 x 10^3 i N/C, find the flux of this field through a square of 10 cm on a side whose plane is parallel to the YZ-plane. What would be the flux through the same square, if the plane makes an angle of 30° with the X-axis.

219) A hollow cylindrical box of length 1m and area of cross-section 25 cm^2 is placed in a three dimensional coordinate system as shown in the figure. The electric field in the region is given by E = 50 x $\hat{i}$ where E is in $NC^{-1}$and x is in metre.

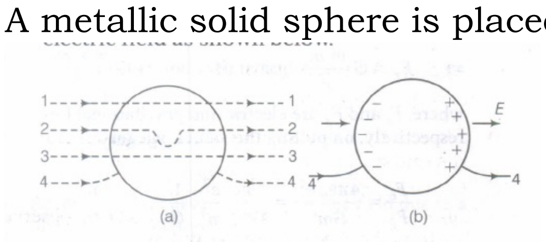


Find
(i) net flux through the cylinder and
(ii) charge enclosed by the cylinder

220) Give one difference between the conductors and insulators.

221) "Electrostatic forces are much stronger than the gravitational forces". Give one example to justify this statement.

222) A metallic solid sphere is placed in a uniform electric field as shown below.



Which path is followed by electric field lines?

223) A point charge +Q is placed in the vicinity of a conducting surface. Draw the electric field lines between the surface and the charge.

224) The electric field induced in a dielectric when placed in an external field is 1/10 times the electric field. Calculate relative permittivity of the dielectric

225) Two identical metallic spherical shells A and B having charges + 4Q and - 10Q are kept a certain distance apart.
A third identical uncharged sphere C is first placed in contact with sphere A and then with sphere B, then spheres A and B are brought in contact and then separated. Find the charge on the spheres A and B

226) A point charge causes an electric flux of - 3.1 x 10^4 N-m^2/C to pass through a spherical Gaussian surface.
i) Find the value of the point charge.
ii) If the radius of the Gaussian surface is doubled, how much flux would pass through the surface?

227) Find the magnitude of electric field intensity due to a dipole of dipole moment 3 x 10^{-8}C-m at a point distance 1 m from the centre of dipole, when line joining the point to the centre of dipole makes an angle of 60° with the dipole axis.

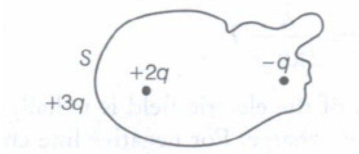
228) An electric dipole consists of two charges of 0.1 μC separated by a distance of 2.0 cm. The dipole is placed in an external field of 10^5 N/C. What maximum torque does the field exert on the dipole?

229) An electric dipole of moment 2 x 10^{-8} C-m is aligned in a uniform electric field of 2 x 10^4 N/C. Calculate the work done in rotating the dipole from 30° to 60°.

230) A box encloses an electrical dipole consisting of charge 5μC and -5μC and of length 10 cm. What is the total electric flux through the box?

231) A charge q is placed at the centre of a cube of side I. What is the electric flux passing through each face of the cube.

232) Figure shows three point charges, + 2q, - q and + 3q. Two charges + 2q and - q are enclosed within a surface S. What is the electric flux due to this configuration through the surface S?



233) One end of a copper wire is connected to a neutral pith ball and other end to a negatively charged plastic rod. What will be the charge acquired by a pith ball?

234) Distinguish between an insulator (dielectric) and a conductor.

235) Why does a nylon or plastic comb get electrified on combing or rubbing but a metal spoon does not?

236) Two metallic spheres having same shape and size, but one of Cu and other of AI, are both placed in an identical electric field. In which metallic sphere will more charge be induced?

237) What causes the charging of an object?

238) What does the additive nature of electric charge mean?

239) When does a charged ring behave as a point charge?

240) What is the cause of quantisation of electric charge?

241) What do you mean by conservative nature of the electric force?

242) If a body contains n_1 electrons and n_2 protons, then what will be the total amount of charge on the body?

243) What is the limitation of Coulomb's law?

244) What does ε(absolute permittivity) signify?

245) Define 1 coulomb (1 C) of electric charge.

246) Write two properties of an electrostatic force.

247) Is the force acting between two point electric charges q_1 and q_2 kept at some distance apart in air, attractive or repulsive when (i) $q_1q_2 > 0$ (ii) $q_1q_2 < 0$?

248) The force on an electron kept in an electric field in a particular direction is F. What will be the magnitude and direction of the force experienced by a proton kept at the same point in the field? Mass of the proton is about 1836 times the mass of the electron.

249) How does the coulomb force between two point charges depend upon the dielectric constant of the intervening medium?

250) State principle of superposition of forces.

251) Define the dielectric constant of a medium. What is its unit?

252) Two electric field lines never cross each other Why?

253) Draw the electric field lines due to a point charge
(i) $Q > 0$ and (ii) $Q < 0$.

254) Draw electric field lines for a system of two charges q_1 and q_2 such that
$(i) q_1 q_2 > 0; q_1 > q_2 > 0$
$(ii) q_1 q_2 < 0; q_1 > |-q_2| < 0, |q_1| > |-q_2|$

255) Draw the electric field lines if
(i) a point charge + q is placed at the centre
(ii) a point charge + q is placed at a distance R/2 from the centre.

256) What is the physical significance of electric field?

257) Define the term electric dipole moment. Is it a scalar or a vector quantity?

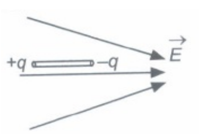
258) What is an ideal (point) dipole?

259) What is the value of $\left|\frac{E_{ax}}{E_{eq}}\right|$ for a short electric dipole?

260) Two point charges +q and -q are placed at a distance d apart. What are the points at which the resultant electric field is parallel to the line joining the two charges?

261) If F is the magnitude of force experienced by a unit charge placed at a distance of 1 em from an infinitely large charged sheet, then what will be the force experienced by the same charge placed at a distance of 2 cm from the same sheet?

262) What is the direction of net force on electric dipole, placed in a non-uniform electric field?



263) When does an electric dipole placed in a non-uniform electric field experience a zero torque but non-zero force?

264) Name the physical quantity whose SI unit is V.m. Is it a vector or a scalar quantity?

265) Define the term electric flux. Write its SI unit.

266) What is a Gaussian surface?

267) What is the use of a Gaussian surface?

268) Why can a Gaussian surface not pass through any discrete charge?

269) Does the charge given to a metallic sphere depend on whether it is hollow or solid? Give reason for your answer.

270) In a medium the force of attraction between two point electric charges, distance d apart is F. What distance apart should these be kept in the same medium so that the force between them becomes
(i) 3F
(ii) $\frac{F}{3}$?

271) An electron and a proton are released in the uniform electric field. Will they experience same force and have same acceleration?

272) Two fixed point charges + 4 e and + e units are separated by a distance 'a'. Where should the third point charge be placed for it to be in equilibrium?

273) Two small balls with equal positive charges q coulomb are suspended by two insulating strings of equal length I metre from a hook fixed to a stand. The whole set up is taken in a satellite into space where there is no gravity. Find the angle between the strings and tension (T) in each string.

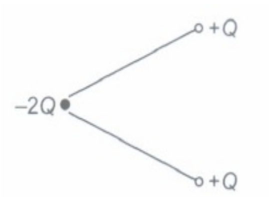
274) An oil drop of mass m and charge - q is to be held stationary in the gravitational field of the earth. What is the magnitude and direction of the electrostatic field required for this purpose?

275) Two point electric charges of unknown magnitude and sign are placed at a distance d apart. The electric field intensity is zero at a point, not between the charges but on the line joining them. Write two essential conditions for this to happen.

276) Two charged spherical conductors, each of radius R, are at a distance d (d > 2R) apart. They carry the charges +q and -q. Will the force of attraction between them be exactly $\frac{q^2}{4\pi\varepsilon_0 d^2}$?

277) The electric field E due to a point charge at any point near it is defined as $E = \lim_{q \to 0} \frac{F}{q}$ where q is the test charge and F is the force acting on it. What is the physical significance of $\lim_{q \to 0}$ in this expression? Draw the electric field lines of a point charge Q when (i) Q > 0 and (ii) Q < 0.

278) Sketch the electric field lines for the following system of charges.



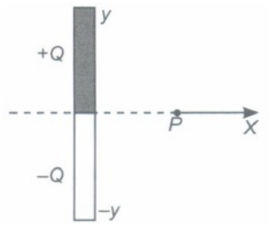
279) Define electric field intensity. Write its SI unit. Write the magnitude and direction of electric field intensity due to an electric dipole of length 2a at the mid-point of the line joining the two charges.

280) Show that the electric field at the surface of a charged con ductor is given by $\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$ where σ is the surface charge density and $\hat{n}$ is a unit vector normal to the surface in the outward direction.

281) A positively charged rod having uniform linear charge density λ C/m all over it, is placed in a hypothetical cube of edge I with the centre of the cube at one end of the rod. Find the minimum possible flux of the electric field through the entire surface of the cube.

282) Define electric flux. Write its SI units. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason.

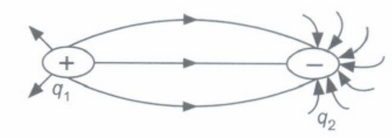
283) The figure given below shows a uniformly charged non-conducting rod. What is the direction of electric field at point P due to the charge on the rod?



284) In the process of charging of a metal sphere by induction, why is a charged rod not removed before earthing the sphere?

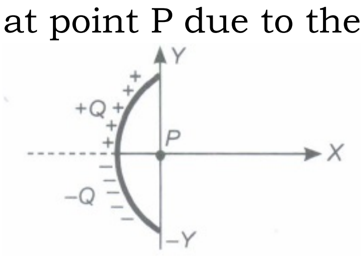
285) Why is repulsion the surest test for checking whether a body has a charge or not?

286) Determine the ratio of magnitudes of two charges q_1 and q_2.



287) The like charges always repel and the unlike charges always attract each other. Is it possible that two like charges attract each other?

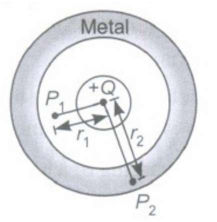
288) The given figure shows a non-conducting semicircular rod. What is the direction of the net electric field at point P due to the charge on the rod?



289) Trace the path of an electron and a proton, if both enter a uniform electric field, with the same velocity, perpendicular to the field.

290) When is electric flux said to be (i) positive (ii) negative?

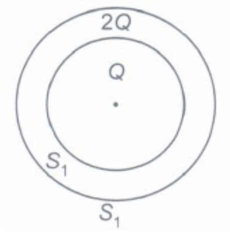
291) A small metal sphere carrying the charge +Q is located at the centre of a spherical cavity in a large uncharged metal sphere as shown in the figure.
Use the Gauss's theorem to find the electric flux at points P_1 and P_2.



292) A point charge Q is at the centre of a conducting shell and another charge q is outside the shell. Now, answer the following:
(a) Does the charge Q experience a force?
(b) Does the charge q experience a force? Explain.

293) An electric dipole is free to move in a uniform electric field. Explain its motion when it is placed
(i) parallel to the field, and
(ii) perpendicular to the field.

294) S_1 and S_2 are two hollow concentric spheres enclosing charge Q and 2Q respectively as shown in figure.



(i) What is the ratio of the electric flux through S_1 and S_2?
(ii) How will the electric flux through the sphere S_1 change, if a medium of dielectric constant 5 is introduced in the space inside S_1 in place of air?

295) Show diagrammatically the orientation of the dipole in the field for which the torque is
(i) maximum,
(ii) half the maximum value, and
(iii) zero.

296) Explain how neutral bodies produce charges when rubbed with each other.

297) A spherical Gaussian surface encloses a charge of 8.85×10^{-10} C.
(i) Calculate the electric flux passing through the surface.
(ii) How would the flux change if the radius of the Gaussian surface is doubled and why?

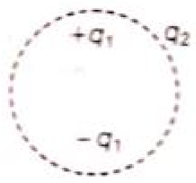
298) An electric dipole of dipole moment 20×10^{-6} Cm is enclosed by a closed surface. What is the net flux coming out of the surface?

299) An electric dipole consists of charges $\pm 2.0 \times 10^{-8}$ C separated by a distance of 2.0×10^{-3} m. It is placed near a long line charge of linear charge density 4.0×10^{-4} C/m as shown in the figure, such that the negative charge is at a distance of 2.0 cm from the line charge. Find the force acting on the dipole.

300) Give any two points of difference between charge and mass.

301) Sketch the electric field lines for two point charges q_1 and q_2 for $q_1 = q_2$ and $q_1 > q_2$ separated by distance d.

302) Consider the charge configuration and a spherical Gaussian surface as shown in the figure.
Which one of the three charges will be the cause of electric field while calculating the flux of the field over the spherical surface?



303) Two large thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17.0×10^{-22}Cm^{-2}. What is E
(i) to the left of the plates,
(ii) to the right of the plates and
(iii) in between the plates?

304) What do you mean by an "ideal electric dipole"?

305) What is meant by the statement, "the electric field of a point charge has spherical symmetry, whereas that of an electric dipole is cylindrically symmetric"?

306) A point charge is placed at the centre of a hollow conducting sphere of internal radius r and outer radius 2r.The ratio of the surface charge density of the inner surface to that of the outer surfacc will be _______

307) The work done in moving a charge partícle betwecn two points in a uniform electric field, does not depend on the path followed by the particle. Why?

308) Draw the pattern of electríc field lines, when a point charge - Q is kept near an uncharged conducting plate.

309) Draw the pattern of electric ficld lines due to an electric dipole.

310) Draw a pattern of electric field lines due to two positive charges placed a distance d apart.

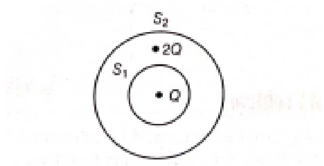
311) Deduce the expression for the electric field E due to a system of two chargesq_1 and q_2 with position vectors r_1 and r_2 at a point r with respect to a common origin.

312) Derive the expression for the torque acting on an electric dipole, when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field, in which it attains a stable equilibrium.

313) Two charged conducting spheres of radii a and b are connected to each other by a wire. Find the ratio of the electric fields at their surfaces.

314) What is the use of Gaussian surface? Also, mention the importance of Gauss' theorem.

315) S_1 and $S_2$are two parallel concentric spheres enclosing chargesQ and 2Q as shown in the figure



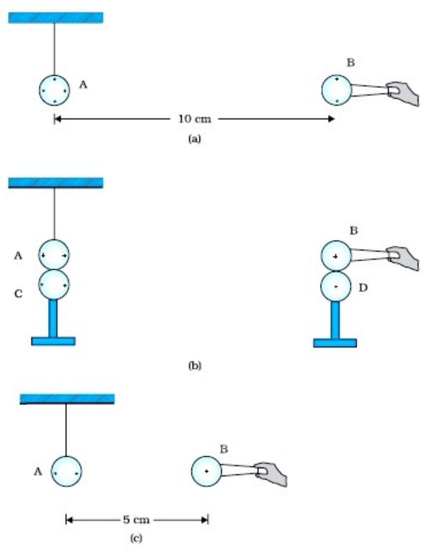
(i) What is the ratio of the electric flux through S_1 and S_2?
(ii) How will the electric flux through the sphere S_1 change, if a medium of dielectric constant $5\varepsilon_0$, is introduced in the space inside S_1 in place of air?

316) What are matter waves? A proton, an electron and an α-particle have the same kinetic energy. Write the de-Broglie wavelengths associated with them in increasing order.

3 Marks 61 x 3 = 183

317) If 10^9 electrons move out of a body to another body every second, how much time is required to get a total charge of 1 C on the other body?

318) A charged metallic sphere A is suspended by a nylon thread. Another charged metallic sphere B held by an insulating handle is brought close to A such that the distance between their centres is 10 cm, as shown in Fig. (a). The resulting repulsion of A is noted (for example, by shining a beam of light and measuring the deflection of its shadow on a screen). Spheres A and B are touched by uncharged spheres C and D respectively, as shown in Fig. (b). C and D are then removed and B is brought closer to A to a distance of 5.0 cm between their centres, as shown in Fig. (c). What is the expected repulsion of A on the basis of Coulomb's law? Spheres A and C and spheres B and D have identical sizes. Ignore the sizes of A and B in comparison to the separation between their centres.



319) What is the force between two small charged spheres having charges of 2 x 10^{-7}C and 3 x 10^{-7}C placed 30 cm apart in air?

320) Four point charges q_A = 2 μC, q_B = –5 μC, q_C = 2 μC, and q_D = –5 μC are located at the corners of a square ABCD of side 10 cm. What is the force on a charge of 1 μC placed at the centre of the square

321) Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the box is 8.0 × 10^3 Nm2/C.
(a) What is the net charge inside the box?
(b) If the net outward flux through the surface of the box were zero, could you conclude that there were no charges inside the box? Why or Why not?

322) A point charge of 2.0 μC is at the centre of a cubic Gaussian surface 9.0 cm on edge. What is the net electric flux through the surface?

323) A conducting sphere of radius 10 cm has an unknown charge. If the electric field 20 cm from the centre of the sphere is 1.5 x 10^3 N/C and points radially inwards, what is the net charge on the sphere ?

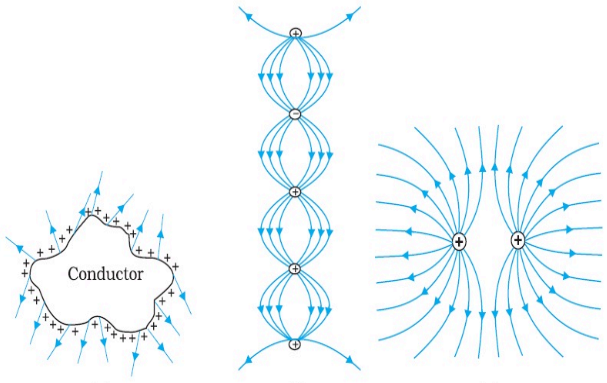
324) An infinite line charge produces a field of 9 × 10^4 N/C at a distance of 2 cm. Calculate the linear charge density.

325) Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude 17.0 x 10^{-22} C/m^2. What is E:
(a) in the outer region of the first plate,
(b) in the outer region of the second plate, and
(c) between the plates?

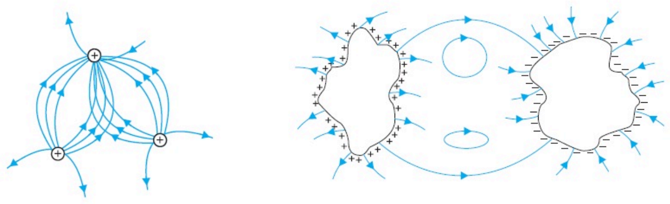
326) An electric dipole with dipole moment 4×10^{-9} C m is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^{4} N/C. Calculate the magnitude of the torque acting on the dipole.

327) Suppose the spheres A and B in Exercise have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with the second, and finally removed from both. What is the new force of repulsion between A and B?

328) Which among the curves shown in Fig. cannot possibly represent electrostatic field lines



(a) (b) (c)



(d) (e)

329) In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is, however, not constant but increases uniformly along the positive z-direction, at the rate of 10^5 NC^{-1} per metre. What are the force and torque experienced by a system having a total dipole moment equal to 10^{-7} Cm in the negative z-direction ?

330) (a) Consider an arbitrary electrostatic field configuration. A small test charge is placed at a null point (i.e., where E = 0) of the configuration. Show that the equilibrium of the test charge is necessarily unstable.

(b) Verify this result for the simple configuration of two charges of the same magnitude and sign placed a certain distance apart

331) A copper slab of mass 2 g contains 2×10^{22} atoms. The charge on the nucleus of each atom is 29 e. What fraction of the electrons must be removed from the sphere to give it a charge of + 2 μC ?

332) Describe some of the differences between charging by induction and charging by contact.

333) Two insulated rods A and Bare oppositely charged on their ends. They are mounted at the centres, so that they are free to rotate and then held in the position shown in the figure, in a view from above. The rods rotate in the plane of the paper. Will the rods stay in those positions when released? If not, then 'fhat position(s) will they move? Will their final configuration(s) be stable?

334) A sphere of lead of mass 10g has net charge -2.5×10^{-9}C.

(i) Find the number of excess electrons on the sphere.

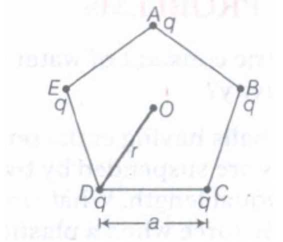
(ii) How many excess electrons are per lead atom? Atomic number of lead is 82 and its atomic mass is 207g / rnol.

335) The sum of two point charges is 7 μC. They repel each other with a force of 1 N when kept 30 cm apart in free space. Calculate the value of each charge

336) Two charges each of + q Coulomb are placed along a line. A third charge -q is placed between them. At what position will the system be in equilibrium?

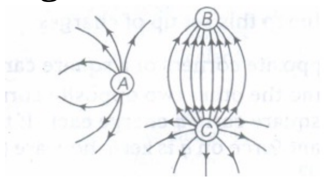
337) Two charges +Q and - Q are kept at points ($-x_2$, 0) and (x_1, 0) respectively, in the XY-plane. Find the magnitude and direction of the net electric field at the origin (0, 0).

338) Five charges, q each are placed at the corners of regular pentagon of side a as shown in the figure.



(i)(a) What will be the electric field at O, the centre of the pentagon?
(b) What will be the electric field at O, if the charge from one of the corners (say A) is removed?
(c) What will be the electric field at O, if the charge q at A is replaced by -q?
(ii) How would your answer be affected, if pentagon is replaced by n-sided regular polygon with charge q at each of its corners?

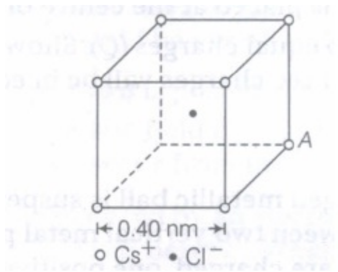
339) Figure shows the electric field lines around three point charges A, B and C



(i) Which charges are positive?
(ii) Which charge has the largest magnitude? Why?
(iii) In which region or regions of the picture could the electric field be zero? Justify your answer.
(a) Near A
(b) Near B
(c) Near C
(d) Nowhere

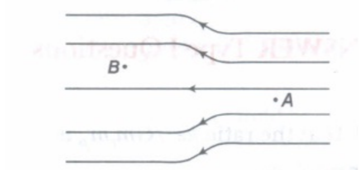
340) The opposite corners of a square carry Q charge each and the other two opposite corners of the same square carry q charge each. If the resultant force on q is zero, how are Q and q related?

341) Figure represents a crystal unit of caesium chloride CsCl. The caesium atoms, represented by open circles are situated at the comers of a cube of side 0.40 nm, whereas a Clatom is situated at the centre of the cube. The Cs atoms are deficient in one electron while the CI atom carries an excess electron.



(i) What is the net electric field on the CI atom due to eight Cs atoms?
(ii) Suppose that the Cs atom at the comer A is missing. What is the net force now on the CI atom due to seven remaining Cs atoms?

342) In the figure below, the electric field lines on the left have twice the separation of those on the right.
(i) If the magnitude of the field of A is 40 N/C, then what force acts on a proton at A?
(ii) What is the magnitude of the field at B?



343) Depict the orientation of the dipole in (i) stable, (ii) unstable equilibrium in a uniform electric field.

344) A charge is distributed uniformly over a ring of radius a. Obtain the expression for the electric field intensity E at a point on the axis of the ring. Hence, show that for points at large distances from the ring, it behaves like a point charge.

345) What will happen, if the field were not uniform?

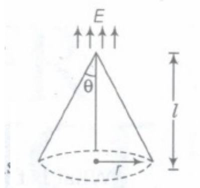
346) An electric dipole consists of two opposite charges each of magnitude 1.0×10^{-6} C separated by 2 cm. The dipole is placed in an external uniform field of 1×10^5 N/ C. Find
(i) the maximum torque exerted by the field on the dipole,
(ii) the work which an external agent will have to do in turning the dipole through 180^o starting from the position, $\theta = 0°$.

347) Use Gauss' law to derive the expression for the electric field between two uniformly charge parallel, sheets with surface charge densities σ and - σ, respectively.

348) A uniform electric field is given as E = $100\hat{i}$ N/C forx > O and E = $100\hat{i}$ N/C for x < 0. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the X-axis, so that one face is at x = +10 cm and other is at x = -10 cm.
(i) What is the net outward flux through each flat face?
(ii) What is the flux through the side of cylinder?
(iii) What is the net outward flux through the cylinder?
(iv) What is the net charge inside the cylinder.

349) A large plane sheet of charge having surface charge density 5 x 10^{-6} c/ m^2 lies in XY -plane. Find the electric flux through a circular area of radius 0.1m, if the normal to the circular area makes an angle of 60° with Z-axis.
[Take, E_o = 8.85 x 10^{-12} C^2 / N - m ^{2}]

350) Consider a region bounded by conical surface as shown in the figure.



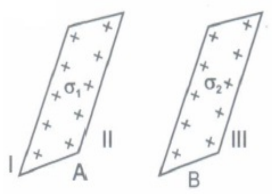
In this region, E is in vertical upward direction, then find the electric field when electric flux is passing through curved surface.

351) An electric dipole of length 2 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $8\sqrt{3}$ N-m. Calculate the potential energy of the dipole, if it has a charge of ± 4 nC.

352) Write Coulomb's law in vector form. Also show that it obeys Newton's third law of motion.

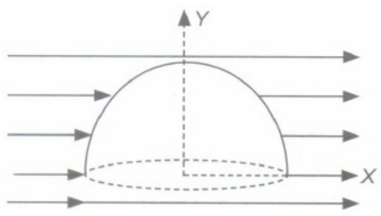
353) Define the term 'electric dipole moment'. Is it a scalar or vector?
Deduce an expression for the electric field at a point on the equatorial plane of an electric dipole of length 2a.

354) (a) A point charge (+Q) is kept in the vicinity of uncharged conducting plate. Sketch electric field lines between the charge and the plate.
b) Two infinitely large plane thin parallel sheets having surface charge densities σ_1 and σ_2 $(\sigma_1 > \sigma_2)$ are shown in the figure. Write the magnitudes and directions of net fields in the regions marked II and III.



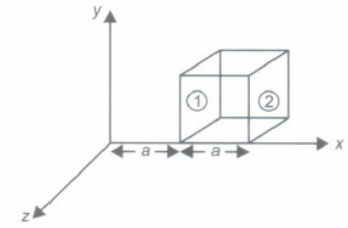
355) An electric dipole is held in a uniform electric field.
(i) Using suitable diagram, show that it does not undergo any translatory motion, and
(ii) derive an expression for the torque acting on it and specify its direction.

356) A hemispherical surface lies as shown in an uniform electric field region. Find the net electric flux through the curved surface if electric field is



(a) along x-axis, and
(b) along y-axis.

357) State Gauss's law in electrostatics. A cube with each side a is kept in an electric field given by $\vec{E} = Cx\hat{i}$ (as is shown in the figure) where C is a positive dimensional constant. Find out



(i) the electric flux through the cube, and
(ii) the net charge inside the cube.

358) Using Gauss's theorem, show mathematically that for any point outside the shell, the field due to a uniformly charged thin spherical shell is the same as if the entire charge of the shell is concentrated at the centre. Why do you expect the electric field inside the shell to be zero according to this theorem?

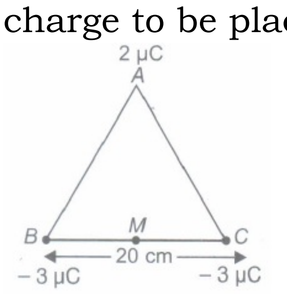
359) Three charges Q_1, Q_2 and Q_3 are placed inside and outside a closed Gaussian surface as shown in the figure.

Answer the following:
(a) Which charges contribute to the electric field at any point on the Gaussian surface?
(b) Which charges contribute to the net flux through this surface?
(c) If $Q_1 = -Q_2$, will electric field on the surface be zero?

360) State Gauss's theorem in electrostatics. Prove that no electric field exists inside a hollow charged sphere.

361) A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Using Gauss's law, derive an expression for an electric field at a point outside the shell. Draw a graph of electric field E(r) with distance r from the centre of the shell for $\mathbf{0} \leq r \leq \infty$.

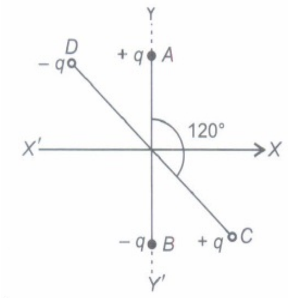
362) Three point charges of +2 μC, -3 μC and -3 μC are kept at the vertices A, B and C respectively of an equilateral triangle of side 20 cm as shown in the figure. What should be the sign and magnitude of the charge to be placed at the mid-point (M) of side BC so that the charge at A remains in equilibrium?



363) An electron moves a distance of 6.0 cm when accelerated from rest by an electric field of strength 2 x 10^4 NC^{-1} Calculate the time of travel.

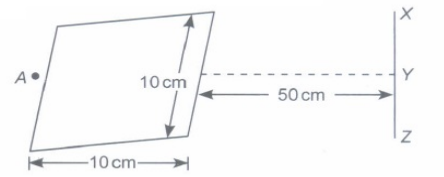
364) An electric dipole of length 4 ern, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ Nm. Calculate the potential energy of the dipole, if it has charge ± 8 nC.

365) Two small identical electrical dipoles AB and CD, each of dipole moment p are kept at an angle of 120° as shown in the figure. What is the resultant dipole moment of this combination? If this system is subjected to electric field $(\overrightarrow{E})$ directed along +X direction, what will be the magnitude and direction of the torque acting on this?



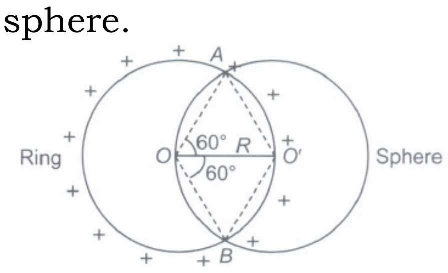
366) Two large parallel thin metallic plates are placed close to each other. The plates have surface charge densities of opposite signs and of magnitude 20 x 10^{-12} C/m^2. Calculate the electric field intensity
(i) in the outer region of the plates, and
(ii) in the interior region between the plates.

367) Given a uniformly charged planet sheet of surface charge density σ = 2 x 10^{17} C/m^2.



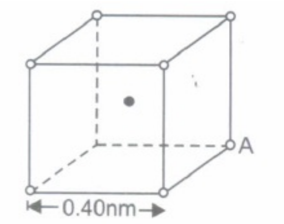
(i) Find the electric field intensity at a point A, 5mm away from the sheet on the left side.
(ii) Given a straight line with three points X, Y and Z placed 50 cm away from the charged sheet on the right side. At which of these points, the field due to the sheet remain the same as that of point A and why?

368) A charge Q is distributed uniformly on a ring of radius R. A sphere of equal radius R is constructed with its centre at the periphery of the ring. Find the flux of the electric field through the surface of the sphere.



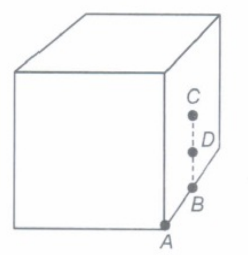
369) The electric field in a region is given by $\vec{E} = \frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}$ with $E_0 = 2.0 \times 10^3$ N/C.
Find the flux of this field through a rectangular surface area of 0.2 m^2 parallel to y-z plane.

370) Figure represents a crystal unit of cesium chloride, CsCI. The cesium atoms, represented by open circles are situated at the corners of a cube of side 0.40 nm, whereas a Cl atom is situated at the centre of the cube. The Cs atoms are deficient in one electron while the Cl atom carries an excess electron.



(i) What is the net electric field on the Cl atom due to eight Cs atoms?
(ii) Suppose that the Cs atom at the corner A is missing. What is the net force now on the CI atom due to seven remaining Cs atoms?

371) What will be the total flux through the faces of the cube (Figure) with the side of length a if a charge q is placed at



(a) A : a corner of the cube.
(b) B : mid-point of an edge of the cube.
(c) C: centre of a face of the cube.
(d) D: mid-point of B and C.

372) Two identical point charges Q are kept at a distance r from each other. A third point charge is placed on the line joining the above two charges such that all the three charges are in equilibrium. What is the magnitude, sign and position of the third charge?

373) An infinitely long cylinder of radius R carries a uniform volume charge density p Cm^{-3}. Obtain an expression for electric field at a point
(a) inside and
(b) outside the cylinder.

374) An uncharged comb after combing hair, when brought near the paper bits attracts them. Answer the following:

(a) Does the mass of comb/paper bit get changed?

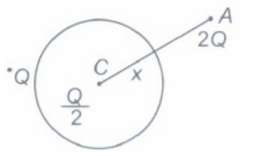
(b) Is paper bit still uncharged?

(c) What is the difference between the charging of a comb and the charging of the paper bits?

375) A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at its centre C and an other charge +2Q is placed outside the shell at a distance x from the centre as shown in figure. Find

(i) the force on the charge at the centre of shell and. at the point A,

(ii) the electric flux through the shell.



376) Prove that when an electric dipole is placed in a uniform electric field, potential energy U is given by U = -p.E.

377) Two charges q_1 and q_2 of 0.1 $\mu\mu$C and -0.1 $\mu\mu$C, respectively are 10 $\overset{\circ}{A}$ apart What is the electric field at a point on the line joining them at a distance of 10 cm from their mid-point?

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Ravi Maths Tuition

Electric Charges and Fields 5

12th Standard

Physics

Case Study Questions 17 x 4 = 68

1) Coulomb's law states that the electrostatic force of attraction or repulsion acting between two stationary point charges is given by

$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$

where F denotes the force between two charges q_1 and q_2 separated by a distance r in free space, E_o is a constant known as permittivity of free space. Free space is vacuum and may be taken to be air practically. If free space is replaced by a medium, then E_o is replaced by (E_ok) or (E_oEr)where k is known as dielectric constant or relative permittivity.

(i) In coulomb's law, F = $k\frac{q_1q_2}{r^2}$, then on which of the following factors does the proportionality constant k depends?

(a) Electrostatic force acting between the two charges

(b) Nature of the medium between the two charges

(c) Magnitude of the two charges

(d) Distance between the two charges

(ii) Dimensional formula for the permittivity constant E_o of free space is

(a) $[\mathrm{ML^{-3}\ T^4\ A^2}]$ (b) $[M^{-1}L^3T^2A^2]$

(c) $[\mathrm{M^{-1}\ L^{-3}\ T^4\ A^2}]$ (d) $[ML^{-3}T^4A^{-2}]$

(iii) The force of repulsion between two charges of 1 C each, kept 1 m apart in vaccum is

(a) $\frac{1}{9\times10^9}$ N (b) $[M^{-1}L^3T^2A^2]$

(c) 9×10^7 N (d) $\frac{1}{9\times10^{12}}$ N

(iv) Two identical charges repel each other with a force equal to 10 mgwt when they are 0.6 m apart in air. (g = 10 ms^{-2}). The value of each charge is

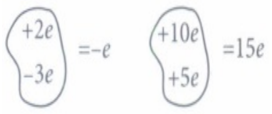
(a) 2 mC (b) 2 x10^{-7} mC (c) 2 nC (d) 2μC

(v) Coulomb's law for the force between electric charges most closely resembles with

(a) law of conservation of energy **(b) Newton's law of gravitation**

(c) Newton's 2^{nd} law of motion **(d) law of conservation of charge**

2) Smallest charge that can exist in nature is the charge of an electron. During friction it is only the transfer of electrons which makes the body charged. Hence net charge on any body is an integral multiple of charge of an electron.



[1.6 x 10^{-19} C] i.e.

q = ± ne

where n = 1,2,3,4, ...

Hence no body can have a charge represented as $1.1e, 2.7e, \frac{3}{5}e,$ etc.

Recently, it has been discovered that elementary particles such as protons or neutrons are composed of more elemental units called quarks.

(i) Which of the following properties is not satisfied by an electric charge?

(a) Total charge conservation **(b) Quantization of charge**
(c) Two types of charge **(d) Circular line of force**

(ii) Which one of the following charges is possible?

(a) 5.8 x 10^{-18}C **(b) 3.2 x 10^{-18}C**
(c) 4.5 x 10^{-19}C **(d) 8.6 x 10^{-19}C**

(iii) If a charge on a body is 1 nC, then how many electrons are present on the body?

(a) 6.25 x 10^{27} **(b) 1.6 x 10^{19}**
(c) 6.25 x 10^{28} **(d) 6.25 x 10^{9}**

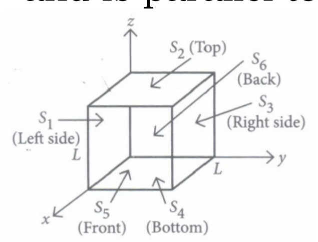
(iv) If a body gives out 10^9 electrons every second, how much time is required to get a total charge of 1 C from it?

(a) 190.19 years **(b) 150.12 years** **(c) 198.19 years** **(d) 188.21 years**

(v) A polythene piece rubbed with wool is found to have a negative charge of3.2 x $1O^{-7}$C.Calculate the number of electrons transferred.

(a) 2 x 10^{12} **(b) 3 x 10^{12}** **(c) 2 x 10^{14}** **(d) 3 x 10^{14}**

3) Net electric flux through a cube is the sum of fluxes through its six faces. Consider a cube as shown in figure,having sides oflength L = 10.0 cm. The electric field is uniform, has a magnitude E = 4.00 x 10^3 N C^{-I} and is parallel to the xy plane at an angle of 37° measured from the +x-axis towards the +y-axis.



(i) Electric flux passing through surface S_6 is

(a) -24 N m^2 C^{-1} **(b) 24 N m^2 C^{-1}** **(c) 32 Nm^2C^{-1}** **(d) -32 N m^2 C^{-1}**

(ii) Electric flux passing through surface s_1 is

(a) -24 N m^2 C^{-1} **(b) 24 N m^2 C^{-1}** **(c) 32 N m^2 C^{-1}** **(d) -32 N m^2 C^{-1}**

(iii) The surfaces that have zero flux are

(a) S_1 and S_3 **(b) S_5 and S_6** **(c) S_2 and S_4** **(d) S_1 and S_2**

(iv) The total net electric flux through all faces of the cube is

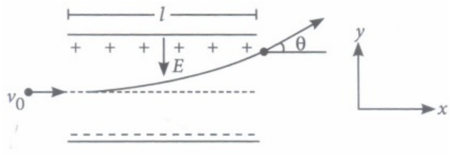
(a) 8 N m^2 C^{-1} **(b) -8 N m^2 C^{-1}** **(c) 24 N m^2 C^{-1}** **(d) zero**

(v) The dimensional formula of surface integral $\oint \vec{E} \cdot d\vec{S}$of an electric field is

(a) [M L^2 T^{-2} A^{-1}] **(b) [M L^3 T^{-3} A^{-1}]**
(c) [M^{-1} L^3 T^{-3} A] **(d) [M L^{-3} T^{-3} A^{-1}]**

4) When a charged particle is placed in an electric field, it experiences an electrical force. If this is the only force on the particle, it must be the net force. The net force will cause the particle to accelerate according to Newton's second law. So

$\vec{F}_e = q\vec{E} = m\vec{a}$



If $\vec{E}$ is uniform, then $\vec{a}$ is constant and $\vec{a} = q\vec{E}/m$. If the particle has a positive charge, its acceleration is in the direction of the field. If the particle has a negative charge, its acceleration is in the direction opposite to the electric field. Since the acceleration is constant, the kinematic equations can be used.

(i) An electron of mass m, charge e falls through a distance h metre in a uniform electric field E. Then time of fall,

(a) $t = \sqrt{\frac{2hm}{eE}}$ (b) $t = \frac{2hm}{eE}$ (c) $t = \sqrt{\frac{2eE}{hm}}$ (d) $t = \frac{2eE}{hm}$

(ii) An electron moving with a constant velocity v along X-axis enters a uniform electric field applied along Y-axis. Then the electron moves.

(a) with uniform acceleration along Y-axis **(b) without any acceleration along Y-axis**

(c) in a trajectory represented as y = ax^2 **(d) in a trajectory represented as y = ax**

(iii) Two equal and opposite charges of masses m_1 and m_2 are accelerated in an uniform electric field through the same distance. What is the ratio of their accelerations if their ratio of masses is $\frac{m_1}{m_2} = 0.5$?

(a) $\frac{a_1}{a_2} = 2$ (b) $\frac{a_1}{a_2} = 0.5$ (c) $\frac{a_1}{a_2} = 3$ (d) $\frac{a_1}{a_2} = 1$

(iv) A particle of mass m carrying charge q is kept at rest in a uniform electric field E and then released. The kinetic energy gained by the particle, when it moves through a distance y is

(a) $\frac{1}{2}qEy^2$ (b) qEy (c) qEy^2 (d) qE^2y

(v) A charged particle is free to move in an electric field. It will travel

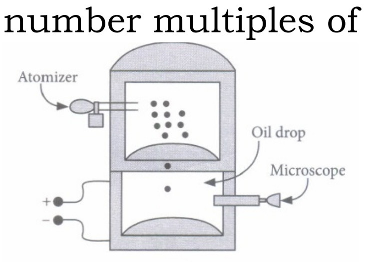
(a) always along a line of force

(b) along a line of force, if its initial velocity is zero

(c) along a line of force, if it has some initial velocity in the direction of an acute angle with the line of force

(d) none of these.

5) In 1909, Robert Millikan was the first to find the charge of an electron in his now-famous oil-drop experiment. In that experiment, tiny oil drops were sprayed into a uniform electric field between a horizontal pair of oppositely charged plates. The drops were observed with a magnifying eyepiece, and the electric field was adjusted so that the upward force on some negatively charged oil drops was just sufficient to balance the downward force of gravity. That is, when suspended, upward force qE just equaled Mg. Millikan accurately measured the charges on many oil drops and found the values to be whole number multiples of 1.6×10^{-19} C the charge of the electron. For this, he won the Nobel prize.



(i) If a drop of mass 1.08×10^{-14} kg remains stationary in an electric field of 1.68×10^{5} N C^{-1}, then the charge of this drop is

(a) 6.40×10^{-19} C (b) 3.2×10^{-19} C
(c) 1.6×10^{-19} C (d) 4.8×10^{-19} C

(ii) Extra electrons on this particular oil drop (given the presently known charge of the electron) are

(a) 4 (b) 3 (c) 5 (d) 8

(iii) A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field 100 V m^{-1}.If the mass of the drop is 1.6×10^{-3} g, the number of electrons carried by the drop is (g= 10 m s^{-2})

(a) 10^{18} (b) 10^{15} (c) 10^{12} (d) 10^{9}

(iv) The important conclusion given by Millikan's experiment about the charge is

(a) charge is never quantized (b) charge has no definite value
(c) charge is quantized (d) charge on oil drop always increases.

(v) If in Millikan's oil drop experiment, charges on drops are found to be $8\mu C, 12\mu C, 20\mu C$ then quanta of charge is

(a) $8\mu C$ (b) $20\mu C$ (c) $12\mu C$ (d) $4\mu C$

6) Gauss's law and Coulomb's law, although expressed in different forms, are equivalent ways of describing the relation between charge and electric field in static conditions. Gauss's law is $\varepsilon_0 \phi = q_{\text{encl}}$, when q_{encl} is the net charge inside an imaginary closed surface called Gaussian surface. $\phi = \oint \vec{E} \cdot d\vec{A}$ gives the electric flux through the Gaussian surface. The two equations hold only when the net charge is in vacuum or air.

(I) If there is only one type of charge in the universe, then ($\vec{E} \rightarrow$ Electric field, $d\vec{s} \rightarrow$ Area vector)

(a) $\oint \vec{E} \cdot d\vec{s} \neq 0$ **on any surface**

(b) $\oint \vec{E} \cdot d\vec{s}$ **could not be defined**

(c) $\oint \vec{E} \cdot d\vec{s} = \infty$ **if charge is inside**

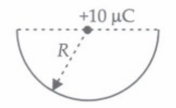
(d) $\oint \vec{E} \cdot d\vec{s} = 0$ **if charge is outside,**

$\oint \vec{E} \cdot d\vec{s} = \frac{q}{\varepsilon_0}$ **if charge is inside**

(ii) What is the nature of Gaussian surface involved in Gauss law of electrostatic?

(a) Magnetic (b) Scalar (c) Vector (d) Electrical

(iii) A charge 10 μC is placed at the centre of a hemisphere of radius R = 10 cm as shown. The electric flux through the hemisphere (in MKS units) is



(a) 20 x 10^5 **(b) 10 x 10^5** **(c) 6 x 10^5** **(d) 2 x 10^5**

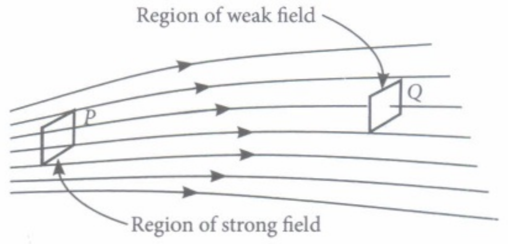
(iv) The electric flux through a closed surface area S enclosing charge Q is ϕ. If the surface area is doubled, then the flux is

(a) 2ϕ (b) $\phi/2$ (c) $\phi/4$ (d) ϕ

(v) A Gaussian surface encloses a dipole. 'The electric flux through this surface is

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{2q}{\varepsilon_0}$ (c) $\frac{q}{2\varepsilon_0}$ **(d) zero**

7) Electric field strength is proportional to the density of lines of force i.e., electric field strength at a point is proportional to the number of lines of force cutting a unit area element placed normal to the field at that point. As illustrated in the given figure, the electric field at P is stronger that at Q.



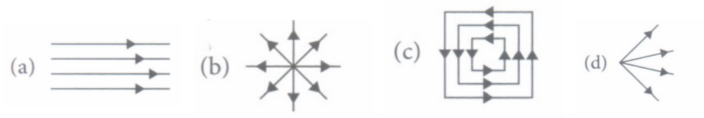
(i) Electric lines of force about a positive point charge are

(a) radially outwards **(b) circular clockwise**
(c) radially inwards **(d) parallel straight lines**

(ii) Which of the following is false for electric lines of force?

(a) They always start from positive charges and terminate on negative charges
(b) They are always perpendicular to the surface of a charged conductor
(c) They always form closed loops
(d) They are parallel and equally spaced in a region of uniform electric field

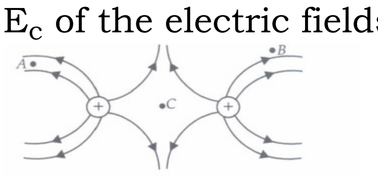
(iii) Which one of the following pattern of electric line of force in not possible in filed due to stationary charges?



(iv) Electric lines of force are curved

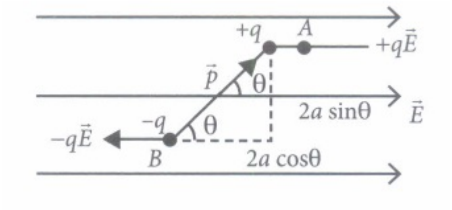
(a) in the field of a single positive or negative charge **(b) in the field of two equal and opposite charges**
(c) in the field of two like charges **(d) both (b) and (c).**

(v) The figure below shows the electric field lines due to two positive charges. The magnitudes E_A, E_B and E_c of the electric fields at points A, Band C respectively are related as



(a) $E_A > E_B > E_C$ (b) $E_B > E_A > E_C$ (c) $E_A = E_B > E_C$ (d) $E_A > E_B = E_C$

8) When electric dipole is placed in uniform electric field, its two charges experience equal and opposite forces, which cancel each other and hence net force on electric dipole in uniform electric field is zero. However these forces are not collinear, so they give rise to some torque on the dipole. Since net force on electric dipole in uniform electric field is zero, so no work is done in moving the electric dipole in uniform electric field. However some work is done in rotating the dipole against the torque acting on it.



(i) The dipole moment of a dipole in a uniform external field $\vec{E}$ is $\vec{P}$Then the torque $\vec{\tau}$ acting on the dipole is

(a) $\vec{\tau}=\vec{P}\times\vec{E}$ (b) $\vec{\tau}=\vec{P}\cdot\vec{E}$ (c) $\vec{\tau}=2(\vec{P}+\vec{E})$ (d) $\vec{\tau}=(\vec{P}+\vec{E})$

(ii) An electric dipole consists of two opposite charges, each of magnitude 1.0 μC separated by a distance of 2.0 cm. The dipole is placed in an external field of 10^5 NC^{-1}. The maximum torque on the dipole is

(a) 0.2×10^{-3}Nm (b) 1×10^{-3}Nm (c) 2×10^{-3}Nm (d) 4×10^{-3}Nm

(iii) Torque on a dipole in uniform electric field is minimum when θ is equal to

(a) 0° (b) 90° (c) 180° (d) Both (a) and (c)

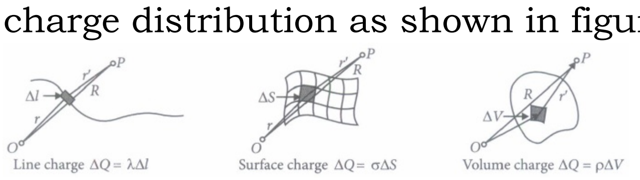
(iv) When an electric dipole is held at an angle in a uniform electric field, the net force F and torque τ on the dipole are

(a) $F=0,\tau=0$ (b) $F\neq0,\tau\neq0$ (c) $F=0,\tau\neq0$ (d) $F\neq0,\tau=0$

(v) An electric dipole of momentp is placed in an electric field of intensity E. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when θ = 90°,the torque and the potential energy of the dipole will respectively be

(a) $pE\sin\theta,-pE\cos\theta$ (b) $pE\sin\theta,-2pE\cos\theta$ (c) $pE\sin\theta,2pE\cos\theta$ (d) $pE\cos\theta,-pE\sin\theta$

9) In practice, we deal with charges much greater in magnitude than the charge on an electron, so we can ignore the quantum nature of charges and imagine that the charge is spread in a region in a continuous manner. Such a charge distribution is known as continuous charge distribution. There are three types of continuous charge distribution : (i) Line charge distribution (ii) Surface charge distribution (iii) Volume charge distribution as shown in figure.



(I) **Statement 1** : Gauss's law can't be used to calculate electric field near an electric dipole.

Statement 2 : Electric dipole don't have symmetrical charge distribution.

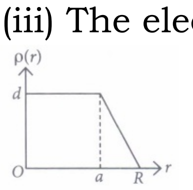
(a) Statement 1 and statement 2 are true **(b) Statement 1 is false but statement 2 is true**

(c) Statement 1 is true but statement 2 is false **(d) Both statements are false**

(ii) An electric charge of 8.85 X 10^{-13} C is placed at the centre of a sphere of radius 1 m. The electric flux through the sphere is

(a) 0.2 N C^{-1} m^2 (b) 0.1 N C^{-1} m^2 (c) 0.3 N C^{-1} m^2 (d) 0.01 N C^{-1} m^2

(iii) The electric field within the nucleus is generally observed to be linearly dependent on r. So,



(a) a=O (b) $a=\frac{R}{2}$ **(c) a=-R** (d) $a=\frac{2R}{3}$

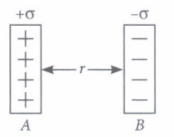
(iv) What charge would be required to electrify a sphere of radius 25 cm so as to get a surface charge density of $\frac{3}{\pi}\mathrm{Cm}^{-2}$?

(a) 0.75 C (b) 7.5 C (c) 75 C (d) zero

(v) The SI unit of linear charge density is

(a) Cm (b) Cm^{-1} (c) C m^{-2} (d) C m^{-3}

10) Surface charge density is defined as charge per unit surface area of surface charge distribution. i.e., $\sigma = \frac{dq}{dS}$ Two large. thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs having magnitude of 17.0 x 10^{-22} C m^{-2} as shown. The intensity of electric field at a point is $E = \frac{\sigma}{\varepsilon_0}$ where ε_0 = permittivity of free space.



(i) E in the outer region of the first plate is
(a) 17×10^{-22} N/C (b) 1.5×10^{-25} N/C (c) 1.9×10^{-10} N/C **(d) zero**

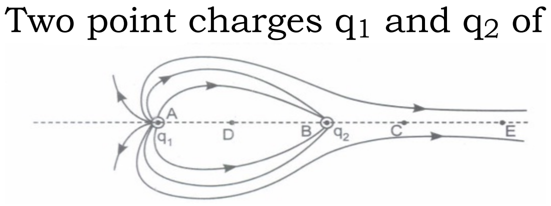
(ii) E in the outer region of the second plate is
(a) 17×10^{-22} N/C (b) 1.5×10^{-15} N/C (c) 1.9×10^{-10} N/C **(d) zero**

(iii) E between the plates is
(a) 17×10^{-22} N/C (b) 1.5×10^{-15} N/C (c) 1.9×10^{-10} N/C (d) zero

(iv) The ratio of E from right side of B at distances 2 cm and 4 ern, respectively is
(a) 1: 2 (b) 2: 1 **(c) 1: 1** (d) $1 : \sqrt{2}$

(v) In order to estimate the electric field due to a thin finite plane metal plate, the Gaussian surface considered is
(a) spherical **(b) cylindrical** (c) straight line (d) none of these

11) Two point charges q_1 and q_2 of unequal magnitude are placed as shown below

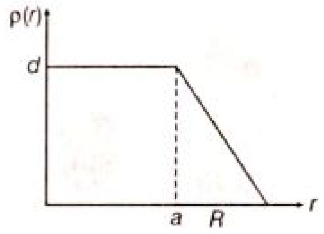


(i) Determine the ratio $q_1 : q_2$
(ii) If one !lull point is at infinity, then where is another null point?
(iii) If q_1 and q_2 are separated by a distance of 10 em, then find the position of a null point.
(iv) Will a positive charge follow the electric lines of force if free to move?

12) An electric dipole is a system consisting of the two equal and opposite point charges seperated by a small and finite distance. If dipole moment of this system is $\vec{p}$ and it is placed in a uniform electric field $\vec{\boldsymbol{E}}$.
(i) Write the expression of torque experienced by a dipole.
(ii) Identify two pairs of perpendicular vectors in the expression.
(iii) Show diagrammatically the orientation of the dipole in the field for which the torque is
(a) Maximum.
(b) Half the maximum value.
(c) Zero

13) A thin conducting shell contains a charge +Q distributed uniformly all overit. Now a point charge $+q_1$ is placed at the centre ofthe shell, and another charge $+q_2$ is pLacedoutside the shell. What is the net force on
(i) charge q_1
(ii) charge q_2
(iii) spherical shell
(iv) also determine charge density on the shell if radius of shell is R.
(v) What is the net electric flux through the sphere?

14) The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density p(r) (charge per unit volume is dependent only on the radial distance r from the centre of the nucleus as shown in figure. The electric field is only along the radial direction.



(i) The electric field at r = R is

(a) independent of a

(b) directly proportional to a

(c) directly proportional to a^2

(d) inversely proportional to a

(ii) Net charge on given system is

(a) $Q=\int \rho_r(4\pi r^2)dr$

(b) $Q=\int \rho_r(\pi r^2)dr$

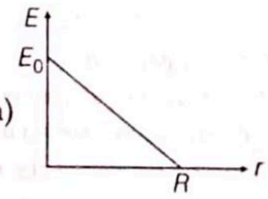
(c) $Q=\int p_r\frac{r^2}{2}dr$

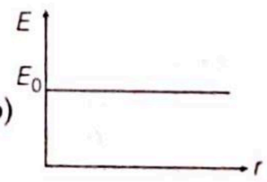
(d) $Q=\int \rho_r(4\pi r^2)$

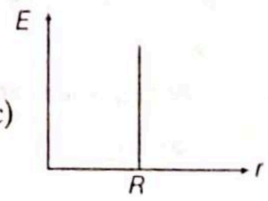
(iii) For a= 0, the value d (maximum value of p as shown in the figure) is

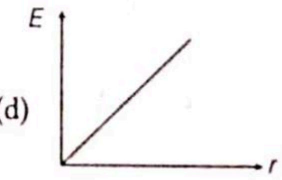
(a) $\frac{3Ze^2}{4\pi R^3}$ (b) $\frac{3Ze}{\pi R^3}$ (c) $\frac{4Ze}{3\pi R^3}$ (d) $\frac{Ze}{3\pi R^3}$

(iv) The correct graph representing the variation of E with r is

(a) 

(b) 

(c) 

(d) 

(v) The electric field within the nucleus is generally observed to be linearly dependent on r. This implies

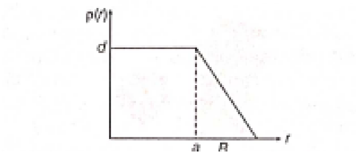
(a) a = 0 (b) a=$\frac{R}{2}$

(c) a = R (d) a=$\frac{2R}{3}$

15) A Faraday cage or Faraday shield is an enclosure made of a conducting material. The fields within a conductor cancel out with any external fields,so the electric field within the enclosure is zero. These Faraday cages act as big hollow conductors. You can put things to shield them from electrical fields. Any electrical shocks the cage receives, pass harmlessly around the outside of the cage.

(i) Which of the following material can be used to make a Faraday cage?
(a) Plastic (b) Glass (c) Copper (d) Wood
(ii) Example of a real-world Faraday cage is
(a) car (b) plastic box (c) lightning rod (d) metal rod
(iii) What is the electrical force inside a Faraday cage, when it is struck by lightning?
(a) The same as the lightning
(b) Half that of the lightning
(c) Zero
(d) A quarter of the lightning
(iv) An isolated point charge +q is placed inside the Faraday cage. Its surface must have charge equal to
(a) zero (b) + q (c) - q (d) + 2q
(v) A point charge of 2 C is placed at centre of Faraday cage in the shape of cube with surface of 9 cm edge. The number of electric field lines passing through the cube normally wiil be
(a) 1.9×10^5 N-m^2/C, entering the surface
(b) 1.9×10^5 N-m^2/C, leaving the surface
(c) 2.01×10^{11} N-m^2/C, leaving the surface
(d) 2.01×10^5 N-m^2/C, entering the surface

16) The nuclear charge(Ze) is non-uniformly distributed within a nucleus of radius R. The charge density p(r) [charge per unit volumne is dependent only on the radial distance r from the centre of the nucleus as shown in figure.The electric field is only along the radial direction.



(i) The electric field at r= R is

(a) independent of a

(b) directly proportional to a

(c) directly proportional to a^2

(d) inversely proportional to a

(ii) Net charge on given system is

(a) $Q = \int \rho_r \left(4\pi r^2\right) dr$

(b) $Q = \int \rho_r \left(\pi r^2\right) dr$

(c) $Q = \int \rho_r \frac{r^2}{2} dr$

(d) $Q = \int \rho_r \left(4\pi r^2\right)$

(iii) For a =0, the value d (maximum value ofp as shown in the figure) is

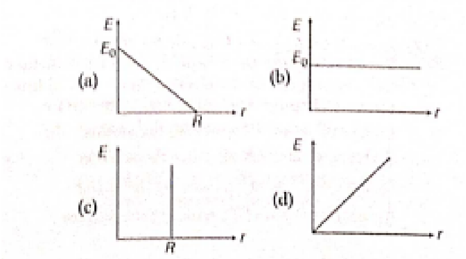
(a) $\frac{3Ze^2}{4\pi R^3}$

(b) $\frac{3Ze}{\pi R^3}$

(c) $\frac{4Ze}{3\pi R^3}$

(d) $\frac{Z}{3\pi R^3}$

(iv) The correct graph representing the variation of E with r is



(v) The electricfield within the nucleus is generally observed to be linearly dependent on r. This implies

(a) a =0

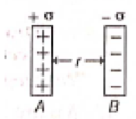
(b) $a = \frac{R}{2}$

(c) a= R

(d) $a = \frac{2R}{3}$

17) Surface charge density is defined as the charge per unit surface area of surface charge distribution.
i.e. $\sigma = \frac{dq}{dS}$

Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs having magnitude of 17.0 x 10^{-22} Cm^{-2} as shown below.



The intensity of electric field at a point is $E = \frac{\sigma}{\varepsilon_0}$
where, E = permittivity of free space.

(i) E in the outer region of the first plate is
(a) 17 x10^{-22} N/C
(b)1,5x10^{-15} N/C
(c)1.9x10^{-16} N/C
(d) zero

(ii) E in the outer region of the second plate is
(a) 17 x 10^{-22} N/C
(b) 1.5 x 10^{-35} N/C
(c) 1.9 x10^{-10} N/C
(d) zero

(ii) E between the plates is
(a) 17 x10^{-22} N/C
(b) 1.5 x 10^{-15} N/C
(c) 1.9 x10^{-10} N/C
(d) zero

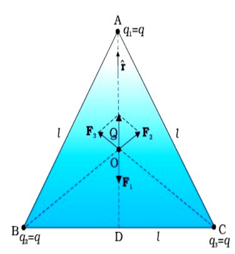
(iv) The ratio of E from right side of B at distances 2 cm and 4 cm, respectively is
(a) 1 : 2
(b) 2 : 1
(c) 1 : 1
(d) 1 : $\sqrt{2}$

(v) In order to estimate the electric field due to a thin finite plane metal plate, the gaussian surface considered is
(a) spherical
(b) cylindrical
(c) straight line
(d) None of these

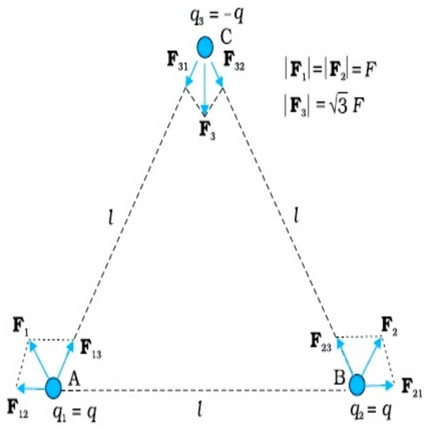
5 Marks 60 x 5 = 300

18) Coulomb's law for electrostatic force between two point charges and Newton's law for gravitational force between two stationary point masses, both have inverse-square dependence on the distance between the charges and masses respectively.
(a) Compare the strength of these forces by determining the ratio of their magnitudes
(i) for an electron and a proton and
(ii) for two protons.
(b) Estimate the accelerations of electron and proton due to the electrical force of their mutual attraction when they are 1 Å (= 10^{-10} m) apart? (m_p = 1.67 x 10^{-27} kg, m_e = 9.11 x 10^{-31} kg)

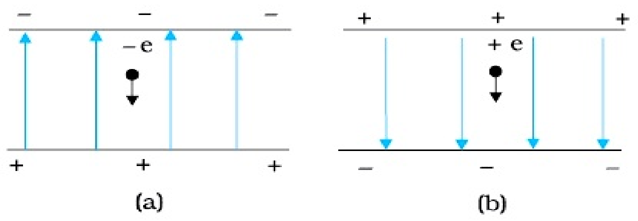
19) Consider three charges q_1, q_2, q_3 each equal to q at the vertices of an equilateral triangle of side l. What is the force on a charge Q (with the same sign as q) placed at the centroid of the triangle, as shown in Figure.



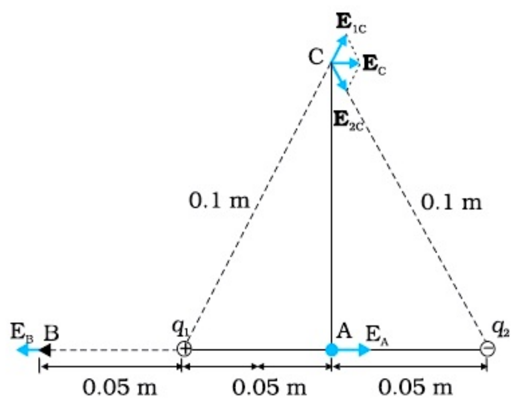
20) Consider the charges q, q, and –q placed at the vertices of an equilateral triangle, as shown in Figure. What is the force on each charge?



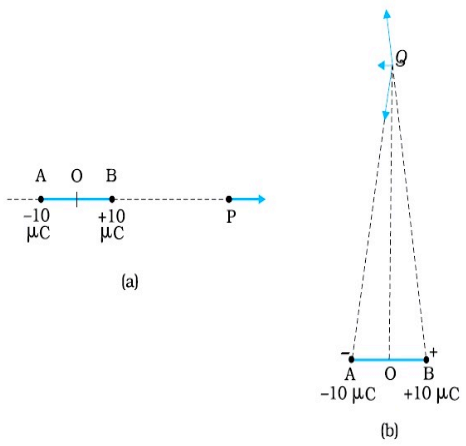
21) An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude 2.0 x 10^4 N C^{-1} [Figure(a)]. The direction of the field is reversed keeping its magnitude unchanged and a proton falls through the same distance [Figure(b)]. Compute the time of fall in each case. Contrast the situation with that of 'free fall under gravity'.



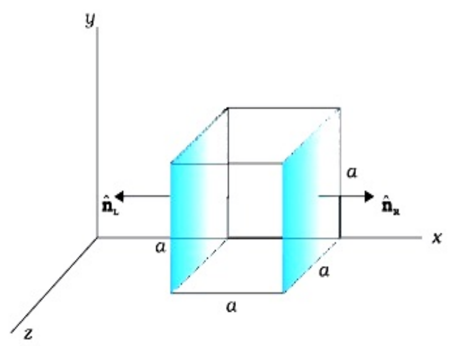
22) Two point charges q_1 and q_2, of magnitude $+10^{-8}$ C and -10^{-8} C, respectively, are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in Figure



23) Two charges ±10 μC are placed 5.0 mm apart. Determine the electric field at (a) a point P on the axis of the dipole 15 cm away from its centre O on the side of the positive charge, as shown in Figure (a), and (b) a point Q 15 cm away from O on a line passing through O and normal to the axis of the dipole, as shown in Figure (b).

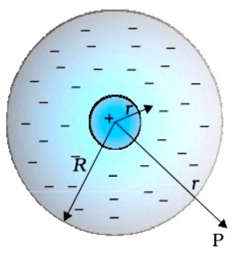


24) The electric field components in Fig are Ex = $\alpha x^{1/2}$, $E_y = E_z = 0$, in which α = 800 N/C $m^{1/2}$. Calculate (a) the flux through the cube, and (b) the charge within the cube. Assume that a = 0.1 m.



25) An electric field is uniform, and in the positive x direction for positive x, and uniform with the same magnitude but in the negative x direction for negative x. It is given that E = 200 $\hat{i}$ N/C for x > 0 and E = –200 $\hat{i}$ N/C for x < 0. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one face is at x = +10 cm and the other is at x = –10 cm (Fig.)
(a) What is the net outward flux through each flat face?
(b) What is the flux through the side of the cylinder?
(c) What is the net outward flux through the cylinder?
(d) What is the net charge inside the cylinder.

26) An early model for an atom considered it to have a positively charged point nucleus of charge Ze, surrounded by a uniform density of negative charge up to a radius R. The atom as a whole is neutral. For this model, what is the electric field at a distance r from the nucleus?



27) The electrostatic force on a small sphere of charge 0.4 µC due to another small sphere of charge – 0.8 µC in air is 0.2 N.
(a) What is the distance between the two spheres?
(b) What is the force on the second sphere due to the first

28) Check that the ratio $ke^2/G\, m_e\, m_p$ is dimensionless. Look up a Table of Physical Constants and determine the value of this ratio. What does the ratio signify?

29) Two point charges q_A = 3 µC and q_B = –3 µC are located 20 cm apart in vacuum.
(a) What is the electric field at the midpoint O of the line AB joining the two charges?
(b) If a negative test charge of magnitude 1.5 x 10^{-9} C is placed at this point, what is the force experienced by the test charge?

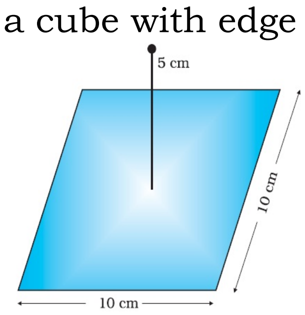
30) A system has two charges q_A = 2.5 x 10^{-7} C and q_B = –2.5 x 10^{-7} C located at points A: (0, 0, –15 cm) and B: (0,0, +15 cm), respectively. What are the total charge and electric dipole moment of the system?

31) A polythene piece rubbed with wool is found to have a negative charge of 3 × 10^{-7} C.
(a) Estimate the number of electrons transferred (from which to which?)
(b) Is there a transfer of mass from wool to polythene?

32) (i) Two insulated charged copper spheres A and B have their centres separated by a distance of 50 cm. What is the mutual force of electrostatic repulsion if the charge on each is 6.5 x 10^{-7} C? The radii of A and B are negligible compared to the distance of separation?
(ii) What is the force of repulsion if each sphere is charged double the above amount, and the distance between them is halved?

33) Consider a uniform electric field E = 3 x 10^3 $\hat{i}$ N/C.
(a) What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the yz plane?
(b) What is the flux through the same square if the normal to its plane makes a 60° angle with the x-axis?

34) A point charge +10 µC is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in Fig What is the magnitude of the electric flux through the square? (Hint: Think of the square as one face of a cube with edge 10 cm.)



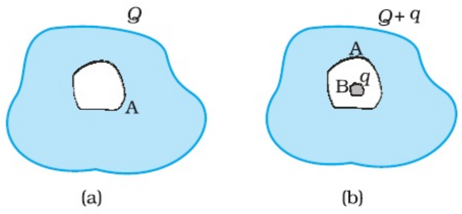
35) A point charge causes an electric flux of -1.0×10^3 Nm^2/C to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge.
(a) If the radius of the Gaussian surface were doubled, how much flux would pass through the surface?
(b) What is the value of the point charge?

36) A uniformly charged conducting sphere of diameter 2.4 m has a surface charge density of 80.0 $\mu C/m^2$.
(a) Find the charge on the sphere.
(b) What is the total electric flux leaving the surface of the sphere?

37) How can you charge a metal sphere positively without touching it?

38) An oil drop of 12 excess electrons is held stationary under a constant electric field of 2.55×10^4 NC^{-1} in Millikan's oil drop experiment. The density of the oil is 1.26 g cm^{-3}. Estimate the radius of the drop. (g = 9.81 m s^{-2}; e = 1.60×10^{-19} C).

39) (a) A conductor A with a cavity as shown in Figure
(a) is given a charge Q. Show that the entire charge must appear on the outer surface of the conductor.
(b) Another conductor B with charge q is inserted into the cavity keeping B insulated from A. Show that the total charge on the outside surface of A is Q + q [Figure (b)].
(c) A sensitive instrument is to be shielded from the strong electrostatic fields in its environment. Suggest a possible way.



40) A hollow charged conductor has a tiny hole cut into its surface. Show that the electric field in the hole is $(\sigma / 2\varepsilon_0)\ \hat{n}$, where $\hat{n}$ is the unit vector in the outward normal direction, and σ is the surface charge density near the hole

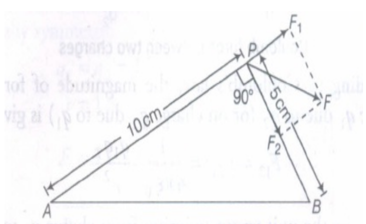
41) Obtain the formula for the electric field due to a long thin wire of uniform linear charge density λ without using Gauss's law. [Hint: Use Coulomb's law directly and evaluate the necessary integral

42) It is now believed that protons and neutrons (which constitute nuclei of ordinary matter) are themselves built out of more elementary units called quarks. A proton and a neutron consist of three quarks each. Two types of quarks, the so called 'up' quark (denoted by u) of charge + (2/3) e, and the 'down' quark (denoted by d) of charge (–1/3) e, together with electrons build up ordinary matter. (Quarks of other types have also been found which give rise to different unusual varieties of matter.) Suggest a possible quark composition of a proton and neutron

43) A particle of mass m and charge (–q) enters the region between the two charged plates initially moving along x-axis with speed v_x (like particle 1 in Fig. The length of plate is L and an uniform electric field E is maintained between the plates. Show that the vertical deflection of the particle at the far edge of the plate is $qEL^2/\left(2mv_x^2\right)$.

44) Suppose that the particle is an electron projected with velocity $v_x = 2.0 \times 10^6$ m s^{-1}. If E between the plates separated by 0.5 cm is 9.1×10^2 N/C, where will the electron strike the upper plate? (|e| = 1.6×10^{-19} C, $m_e = 9.1 \times 10^{-31}$ kg.)

45) Find the magnitude of the resultant force on a charge of 1μC held at P due to two charges of $+ 2 \times 10^{-8}$ C and $- 10^{-8}$ C at A and B, respectively. Given, AP = 10cm, BP = 5cm and ∠APB = 90°,



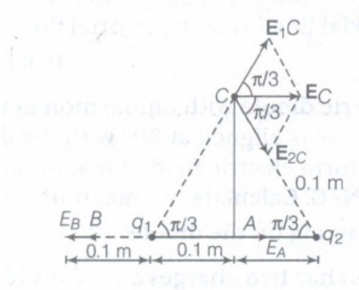
46) Two equal positive charges, each of 2μ C interact with a third positive charge of 3μ C situated as shown in figure. Calculate the magnitude and direction of the force on the 3μ C charge.

47) A free pith-ball of 8 g carries a positive charge of 5 x 10^{-8}C. What must be the nature and magnitude of charge that should be given to a second pith-ball fixed 5 cm vertically below the former pith-ball, so that the upper pith-ball is stationary?

48) (i) Draw a graph of E versus r for r > > a.
(ii) If this dipole is kept in a uniform external electric field E_0, diagrammatically represent the position of the dipole in stable and unstable equillibrium and write the expressions for the torque acting on the dipole in both the cases.

49) The electric field at a point on the axial line at a distance of 10 cm from the centre of an electric dipole is 3.75 x10^5 N/C in air, while at a distance of 20 cm, the electric field is 3 x 10^4 N/C. Calculate the length of an electric dipole

50) A two point charges q_1 and q_2 of magnitude 10^{-7} C and - 10^{-7} C, respectively are placed 0.2 m apart. Calculate the electric fields at points A, B and C as shown in the figure.

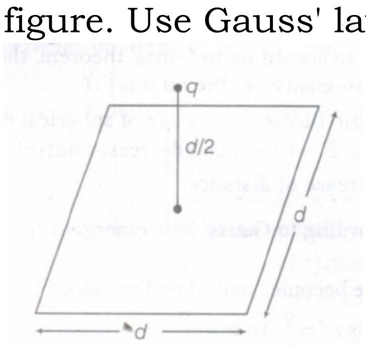


51) (i) Calculate the maximum torque experienced by a water molecule whose electric dipole moment is 6.2 x 10^{-30} C-m, when it is placed in an electric field of intensity 10^6 N/C.
(ii) Determine the work that must be done to take a water molecule aligned with the above field and set it anti-parallel to the field.

52) (i) Define electric flux. Write its SI unit. Gauss' law in electrostatics is true for any closed surface, no matter what its shape or size is. Justify this statement with the help of a suitable example.

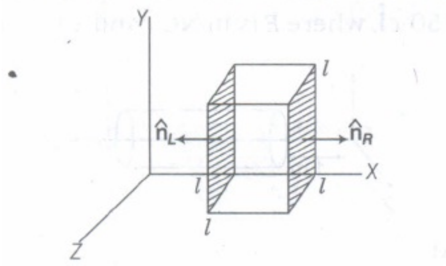
53) An infmitely large thin plane sheet has a uniform surface charge density $+\sigma$. Obtain the expression for the amount of work done in bringing a point charge q from infinity to a point, distant r, in front of the charged plane sheet.

54) (a) Define electric flux. Is it a scalar or a vector quantity?
A point charge q is at a distance of d/2 directly above the centre of a square of side d, as shown in the figure. Use Gauss' law to obtain the expression for the electric flux through the square.



(b) If the point charge is now moved to a distance d from the centre of the square and the side of the square is doubled, explain how the electric flux will be affected.

55) The electric field components in given figure are $E_x = \alpha x^{1/2}$, $E_y = E_z = 0$, in which α= 600 N/ C-$m^{1/2}$.



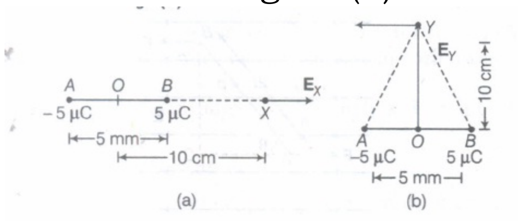
Calculate (i) the flux through the cube and
(ii) the charge within the cube. Assume that l = 0.1m.

56) Two point charges 4μC and + 1 μC areseparated by a distance of 2 m in air. Find the point on the line joining charges at which the net electric field of the system is zero.

57) Two charges ± 5 μC are placed 5 mm apart. Determine the electric field at

(i) a point X on the axis of dipole 10 cm away from its centre 0 on the side of the positive charge' as shown in Figure (a).

(ii) a point Y, 10 cm away from centre a on a line passing through a and normal to the axis of the dipole as shown in Figure (b).



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